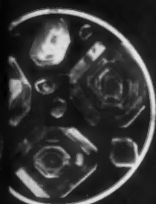
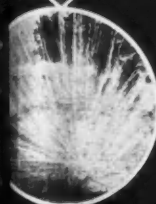


CHEMISTRY



JULY
1947



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Dinner by Capsule

➤ LAZY by nature, people are always hoping that "Science" will return them to the state of infantile bliss in which plenty of food comes their way without requiring any work on their part. No fields to till, no animals to raise and slaughter, no "slaving over a hot stove," no dishes to wash! Rapture!

The first reaction to Woodward's synthesis of portein is naturally the prediction that the day of the synthetic beefsteak is closer at hand. Only a little farther off is the concentrated ration, by which nourishment for the day may be swallowed in capsule form with a gulp of water.

Like atomic energy and interplanetary travel, this is one of the situations the science fiction writers have mulled over so long that they seem commonplace. Yet they turn suddenly appalling now that they are so close that they must be dealt with on the plane of reality, by men whose training and outlook is anything but scientific.

The polymerization reaction which Woodward has discovered and applied so brilliantly comes amazingly close to life processes in its ability to carry on by itself. Of course, the dinner by capsule idea is another mirage, for the animal organism is the product of evolution by hit-or-miss, trial-and-error methods. It probably would not function on a diet of concentrated essentials. The price to be paid for such unrealistic efficiency would be a new crop of mysterious malaises due to lack of accustomed "impurities." But--

Suppose we could set a petroleum distillation plant to work synthesizing amino acids, polymerizing them to protein of an edible variety. What would we do with the food? Feed the starving? Or provision a conquering army to ride them down?

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► *STRUCTURE of protein analogues is demonstrated by Dr. Robert B. Woodward, Associate Professor of Chemistry at Harvard University, who has discovered how to build them. The molecules consist of long chains of carbon and nitrogen atoms. At the points Dr. Woodward has marked X and Y attachment of various organic groups give different properties to the resulting protein substances.*

Artificial Protein Fibers

► THE ARTIFICIAL manufacture of protein fibers announced at Harvard promises:

Synthetic meat better than beef-steak. Chemical germ fighters better than penicillin and streptomycin. New factory-made textiles silkier than silk. And a new approach toward building

artificially the chemical structures which are the basis of life.

This is what Dr. Robert B. Woodward, Harvard's 30-year old chemist, did:

He linked together by the thousands the simple nitrogen-containing structures (amino acid anhydride

molecules.) He made the first successful synthesis of fibrous protein molecules as complex as those in the living human body or other living structures. He induced protein molecules to polymerize (join one to another in long chains) in much the same way that hydrocarbon molecules polymerize to form synthetic rubber.

Already artificial compounds like some of the germ-killing substances produced by soil bacteria have been made in the Harvard laboratories. The new artificial antibiotics are promising in chemical structure and similar to the natural gramicidin, tyrocidin and bacitracin germ-killers. But they are too recently made to be tested yet in actual germ-fighting.

Giant protein molecules in thick and viscous solution have been squirted through a hypodermic needle into the air to make a silk thread, the way a spider does it. Thin films of the new plastic have been made—first of a new protein family of plastics that may become as well known as rayon, nylon and cellulose sheeting.

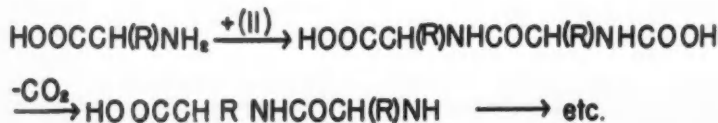
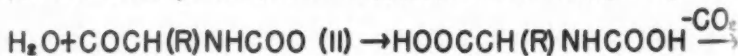
Dr. Woodward found that previous experimenters were on the wrong track when they expected protein molecules to link up by losing water. Loss of carbon dioxide allows the linkage in the newly-discovered process.

In the description published in the Journal of the American Chemical Society, Dr. Woodward and his associate, Dr. C. H. Schramm, tell in formulae their method of growing the fairly simple amino acid anhydrides into complex polymers in the chemical solvent benzene, with a very small amount of water to start the reaction. Throwing off carbon dioxide, the molecules join in long chains that can weigh a million times the hydrogen atom—a size that has never before been achieved in artificially made protein. (See diagram at bottom of page).

The door has been opened by these researchers to the study of complex protein products basic to life itself. A new chemical view of blood, meat, milk, hair, fingernails, and thousands of other things in the animal body is now possible. The new synthesis may bring us closer to synthesis of protein or meat-like food from inorganic or non-agricultural materials.

Dr. Woodward is the chemist who worked out a synthesis of quinine in 1944.

Attempts to understand the structure of the giant protein molecule date back about one hundred and fifty years. The first steps toward the solution of this chemical puzzle were





► *WILL PROTEIN SYNTHESIS help us solve the food supply problem? By 1969, the experts on population calculate, at the present rate of increase, the amount of food that at present feeds four people will have to be divided among five. This coming demand is symbolized in the picture by the empty fork. Photograph by Fremont Davis, Science Service Staff Photographer.*

taken when amino acids were split off by hydrolysis. This reaction can be performed by boiling the protein substance with alkalis, with acids or with neutral solutions of certain salts. Various organic materials are obtained. Among them at least 21 amino acids have been isolated and their chemical structures proved by syntheses.

After chemists had taken these building blocks out of the protein

molecule and learned enough about them to be able to build such compounds from inorganic material, they tried to build protein out of amino acids. Since hydrolysis (action of water) was the key to the breakdown of the protein molecule, they assumed that they could force two amino acids to combine by extracting water from their molecules. Many organic compounds are formed in this way. But what successes they were able to

achieve by this reaction did not result in protein.

The chemist whose name comes immediately to mind in connection with linkage of amino acids is Emil Fischer, who was born in Germany in 1852 and died in 1919. He was able to join together eighteen amino-acid groups laboriously, one by one, to form what was somewhat over-enthusiastically hailed as synthetic beefsteak. He worked out the "peptide linkage" which shows how the acid radical of one molecule catches hold of the amino group in the next. But he never got hold of the magic key which sets the molecules joining up of their own accord.

The distinguishing feature of every amino acid, no matter how long and complicated the chain of carbon atoms composing it, is one carbon atom which holds an amino group (NH_2) and a carboxyl group (COOH) in ad-

joining positions. Fischer found that when two of these compounds join, the linkage is between one carboxyl and the next amino radicals, but he was wrong when he assumed that it is water that splits off when the combination occurs.

It now appears from Dr. Woodward's work that, when dissolved in benzene, with a very small amount of water present to start the reaction, amino acids will join through this same peptide linkage to form a temporary addition product which becomes stable by throwing off a molecule of carbon dioxide from the carboxyl group. As this occurs a new active center is generated which hitches on another amino acid group, and the reaction continues of its own accord, without further effort by the synthesizer. It is much easier than Fischer thought, now that the way has been found.

Emil Fisher Predicted Synthesis

Over forty years ago, Emil Fischer, in reporting his researches, looked ahead and forecast the problems and the general solution of the major research involved in the constitution of the protein molecule. His papers on the subject are classics. He brought them together in 1906 in a two volume work under the title, UNTERSUCHUN-

GEN ÜBER AMINOSAUREN, POLYPEPTIDE UND PROTEINE 1899-1906. The following selection, translated especially for CHEMISTRY by Helen M. Davis, is the climax of the address in which he sums up his work on proteins. It is peculiarly appropriate in view of Woodward's synthesis.

► THE METHODS already described for building up the polypeptides are so manifold that the making of numerous and quite complicated combinations of the natural amino acids is possible, if work and expense are not spared.

But the indiscriminate increase of

these substances would perhaps not be worth the trouble. More important, it seems to me, will be the necessity for practice in experimental handling of the synthetic products to find out newer methods for splitting the natural groupings out of the peptides. The formation of Glycin-d-

alanin-anhydride from silk offers the first example of this kind. It seems to me possible to base upon it the hope that in the not too far distant future, we may be able to isolate the most important components of the natural peptones and even of the albuminoses, and to reproduce them artificially. But if the putting together of many different proteins to make a long list of isolated individuals is attempted, there will be work for many hands.

Even more difficult, naturally, is the problem of the true albumens, since, for their reconstruction out of the first products of hydrolysis completely new methods must be worked out and, once these principles are found, their application in every single case will most likely be a tedious job. The question may now be asked whether the end result is proportional to the trouble expended. This depends, in my opinion, upon the advantage which biological research can obtain from it, and this in turn is dependent upon the manner in which this synthesis is realized.

If today, through some lucky chance, with the help of some brutal reaction, for example by melting together some amino acids in the presence of a dehydrating agent, we should succeed in putting together a true protein, and if it were further possible, which is still more unlikely, to identify the artificial product with a natural substance, little would be accomplished for the chemistry of the proteins and, for biology, practically nothing at all.

A synthesis of this sort I might liken to a traveller who rushes through a country in a fast train and afterward

can tell little about it. The case is quite otherwise if the synthesis is forced to proceed step by step and the molecule built up bit by bit, as has been described for the polypeptides. This is like the foot-traveller who finds his way step by step with close attention, who must try out many paths, till he has found the right one. He learns in his long, painstaking journey not only to know the geography and topography of the country but also becomes acquainted with the language and the customs of the inhabitants. When he has finally reached his goal, he is able to find his way correctly into every corner of the country, and, if he writes a book about it, other people will be able to do it too.

For this reason I might consider it at this time a piece of good fortune that the synthesis requires the creation of numerous new methods of construction, or recognition and of isolation, and thorough study of hundreds of intermediate products, before we can succeed with the proteins. If these methods are the ultimate ones they must serve not only thus, to build up all the proteins of nature and still more than she has produced; they will probably serve also to clarify the numerous and remarkable derivatives of protein, such as ferments, toxins, etc. which play so great a role.

In short, we may expect that, through profound and wide-spread work in synthesis, this whole territory in the field of chemistry, which is now so dim, will be able to draw from biology a great part of the aid needed for the solution of its chemical problems.

Carbon 14 Constantly Created

► COSMIC RAYS are constantly creating radioactive carbon, and apparently have been doing so for ages. Since carbon is an essential element in all living things, we are all full of these radioactive atoms, take in more with every mouthful of food we eat, lose some in our body wastes and with every breath we exhale. What role this ray-created radioactive carbon plays in our lives nobody knows, for its existence has only just been discovered.

There were theoretical reasons for supposing it might exist, but demonstration of its actual presence in living organisms and in recently dead organic matter has now been made by a six-man research team.

The theoretical suggestion was which they started was that if a cosmic ray should strike a nitrogen atom in a certain way it would convert it into an atom of radioactive carbon, with an atomic weight of 14, as compared with 12 for ordinary carbon. Carbon 14 is fairly long-lived for a radioactive element; its half-life is 5,000 years. But given long enough, it all breaks down into other elements and thus vanishes.

The researchers tackling the problem reasoned that if they could get carbon samples of very recent organic origin, some of the atoms might be of the C14 variety. Contrariwise, carbon samples of quite ancient organic origin should contain few or none of these radioactive atoms.

An easy way to collect carbon samples is to capture some methane gas, which has one atom of carbon and four of hydrogen in each of its molecules. Methane is produced in the bacterial fermentation of decaying matter; it is also given off by some kinds of petroleum.

The researchers got their "recent" methane from Baltimore's city sewage disposal plant, their "ancient" gas from crude oil. They used the lofty towers of a commercial oil refinery to concentrate their samples, in order to get the largest possible quantity of radioactive carbon in a relatively small volume. Then they tested their two samples with Geiger counters, which, as everybody has known since Bikini, sound off with a tick when a radioactive atom explodes in their vicinity.

They had previously calculated the number of ticks they ought to get per minute from "recent" methane, or as they called it, biomethane. The Geiger counters ticked off a count very close to the calculated value. From the "ancient" or petromethane they got very few ticks, which was also according to previous calculation.

They now think that the radioactive carbon content can be used as a means of telling the age of any given piece of organic material that hasn't been dead too long—a Pharaoh's mummy, for example, or the skull of a cave man. There are other possible uses, which are being explored.

The research team that did this work consists of E. C. Anderson and W. F. Libby of the University of Chicago, and S. Weinhouse, A. F. Reid, A. D. Kirshenbaum and A. V. Grosse of the Houdry Process Corporation.

Cosmic Rays and Sunspots

► AN ANSWER to one of the mysteries of the universe was suggested at the recent meeting of the National Academy of Sciences.

The mystery: Where do cosmic rays come from?

The solution: Some cosmic rays at some times come from the sun. This theory, contradicting the idea of many scientists, was presented to the Academy by Scott E. Forbush of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

He offered evidence that some cosmic rays may come from solar flares in the neighborhood of sunspots. If they do, then flares on other stars than our sun may account for all the rest of the cosmic rays which bombard the earth from outer space.

Cosmic rays, more powerful than atomic radiations, pierce your body more than 20 times each second. The reason you survive this attack is that so few of these rays reach the earth.

Dr. Frank H. J. Figge of the University of Maryland Medical School recently reported experiments linking cosmic rays with cancer. He believes cosmic rays may act on certain chemicals in the human body to start cancers.

Clues to the solution of the mysterious origin of cosmic rays came from the sunspots that interfere with your

enjoyment of shortwave radio broadcasts.

When sun flares appear, Mr. Forbush explained, shortwave radio broadcasts may be wiped out. This is because the flares near the sunspots send out ultraviolet light. The light strikes the ionosphere over our heads. Shortwave radio broadcasts are normally reflected from the ionosphere.

When the ionosphere is attacked by the ultraviolet light from sun flares, the broadcasts do not get through.

Scientists at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington keep records of these disturbances. They also have instruments which record the intensity of cosmic rays bombarding the earth. These two sets of records may give scientists the first real clue to the origin of cosmic rays.

Mr. Forbush said three unusual and sudden increases in cosmic rays have been recorded in the last ten years. All three of these periods of increased cosmic ray activity were at the same time as radio fadeouts and sun flares. This made Mr. Forbush suspect that the sunspot flares are responsible for some of the cosmic rays which bombard us.

The flares during the three periods of cosmic ray increase were extremely intense and unusually long. No cosmic ray increases were noticed during other flares at that time.

Cosmic ray observations were made at widely separated points. At Cheltenham, Md., Godhavn, Greenland, and Christchurch, New Zealand, the unusual increases were noted at the time of the three flares. Near the magnetic equator, at Huancayo, Peru,

no increased cosmic ray activity was observed.

The flares and cosmic ray increases were recorded for Feb. 28, and March 7, 1942, and July 25, 1946.

Sun flares act like giant-size betatrons, one of the atom-smashers of modern science, according to the new theory of cosmic rays.

Mr. Forbush explained that it is known that there are very strong magnetic fields in the region of sunspots. These magnetic fields are continually changing in intensity. This sets up an electrical field.

The electrical field generates powerful particles which reach the earth. These particles are the cosmic rays which created the three periods of intense cosmic ray activity, Mr. Forbush contended.

This same process on stars throughout the universe sends a continuous bombardment of cosmic rays through space to the earth.

Oddly enough, it has been calculated that the total effect of the cosmic rays reaching the earth's surface is about equal to the light from the stars.

Invisible Tungsten Wire

► TUNGSTEN, the metal that is used for light bulb filaments, has been made into a wire that is so thin that a pound of it would stretch in a single strand 950 miles.

The wire is 0.00018th inch in diameter, and was produced by the Westinghouse Lamp Division at Bloom-

field, N. J., for use in an amplifying tube for the Bell Laboratories.

One thousand feet of the thin wire, reeled on a bobbin, is invisible to the naked eye, and a 20-layer stack of the wire is about the thickness of a sheet of newspaper.

On the Back Cover

► URANIUM FISSION takes place directly on the photographic plate in a process recently developed by Eastman Kodak Research Laboratories, and records itself in the form that appears on the back cover photograph. Soaked in a solution of uranium nitrate, the plate is exposed to neutron bombardment. When a target atom of uranium fissioned the two resulting fragments flew off in opposite directions, making a track that looks like one long straight line. The starry firmament in the background is composed of developed silver grains.

**Standards of Chemical Training
Set Up by American Chemical Society**

Professional Training in Chemistry

► SINCE 1936 the American Chemical Society Committee on Professional Training has been diligently studying the complex problems involved in setting up standards and devising means for evaluating chemistry departments in colleges, technical schools, and universities which provide training leading to the qualification of men and women as professional chemists and provide professional status in the Society in the minimum period of time. The procedure adopted by the Committee has been set forth in progress reports presented to the Council at every national meeting of the Society beginning with the meeting at Chapel Hill, North Carolina, April 1937. There have been three special meetings: Chicago, Illinois, December 1940; New York, New York, February 1941; Rochester, New York, October 1945.

Our surveys have indicated that a certain degree of flexibility should in fairness be exercised in applying the requirements to individual institutions. Provision should be made for taking care of differences of minor importance, such as a different distribution of time between laboratory and lecture work in a given course from that indicated in the requirements.

The Committee is authorized to make such adjustments in the requirements submitted as are deemed by the Committee to be desirable, provided that the changes made do not result in

any reduction in the general standards which have been set up.

Minimum Standards

The primary objects of establishing standards are (1) to give educational institutions a pattern that will serve as a basis for determining the extent and quality of the teaching personnel, the required physical equipment, and the necessary annual budget for sustaining a proper chemical educational program; (2) to provide the prospective chemist with necessary information as to the proper program of study; (3) to list the institutions where adequate chemical training may be obtained for a professional career; (4) to provide industrial organizations with information concerning institutions that provide adequate chemical training of men and women.

After careful consideration of the whole problem of professional training, it became evident at once that nothing could be done until practical minimum standards for a chemical curriculum had been set up. As a basis for such standards the definition of "professional chemist" as proposed by the Committee on the Professional Status of the Chemist and adopted by the Council of the American Chemical Society was kept in mind. The Committee has formulated its requirements after a study of the curricula which have been evolved and adopted in the United States by colleges, universities, and technical schools during the past

several years. It has attempted to include merely what it believes to be the minimum that will provide adequate training for a professional career as a chemist.

The minimum standards proposed are:

The chemistry department must be organized as an independent administrative unit with a separate budget under the control of the department. The inclusion of any or all branches of chemistry or chemical engineering is permitted.

Faculty Requirements

1. The administrative head of the chemistry department must have been adequately trained in the field of chemistry.

2. The size of the staff must be commensurate with the diversity of courses offered. A majority of the members of the staff (professors to instructors, inclusive) must have been awarded the Ph.D. degree in chemistry on the basis of graduate studies and theses, or their equivalent; and any other members of the staff must have abilities and (training) knowledge of the subject which satisfy the Committee, and should normally be on limited tenure. It is not advocated that people of this type who have achieved tenure should have their status changed. It is assumed that all lectures will be given by competent members of the staff as judged by their training and experience.

3. Evidence of individual research productivity will be considered in appraising staff quality.

4. Staff members must not have unreasonable teaching loads. Research

productivity should be duly considered in assigning teaching loads.

5. There must be evidence that the school has a salary range for each faculty rank so that well trained and qualified personnel will accept faculty appointments and feel there is opportunity, both professionally and financially, for future growth.

6. There must be evidence that faculty appointments are not excessively made from the school's own graduates or post graduates.

7. Active participation of each staff member in some national or regional society in his field of specialization will be considered by the Committee in approving chemistry departments for professional training.

8. Lectures and quiz sections must not be placed in charge of undergraduate students. Laboratory sections must be in responsible charge of faculty members or graduate assistants, although a limited use of undergraduate assistants for grading papers, preparing apparatus, etc., is permissible.

9. Quiz and laboratory sections should not exceed thirty students.

Facility Requirements

1. The laboratories must have standard laboratory fixtures and must be equipped at least with water, gas, adequate ventilation, lighting, and proper safety (i.e. the use of safety goggles by students and instructors in performing certain experiments, etc.) and fire protection. Adequate space for each student must be supplied. Chemicals and apparatus must be sufficient to allow each student to perform independently (except for some experiments in physical chemistry) the experiments de-

scribed in recognized, modern texts for beginning and advanced courses.

2. Adequate library facilities must be provided. Preferably, the chemical library should be in the chemistry building in quarters designed for good library practice so that students will find it easy to use.

3. Standard modern texts must be used.

4. The university must satisfy the Committee that the department will be helped financially to the extent that it can meet the above requirements.

For Bachelor's Degree

The minimum course requirements in chemistry for the Bachelor's degree must consist of four basic year courses in general chemistry (which may include qualitative analysis), analytical chemistry, physical chemistry, and organic chemistry, together with at least one advanced course. These courses must meet the following general requirements:

1. General chemistry (high school algebra and geometry should be prerequisites) which may include qualitative analysis, comprising the equivalent of thirty weeks* of instruction with three hours of lectures or recitations a week, and four to six hours of laboratory a week.

2. Quantitative analysis, comprising the equivalent of thirty weeks of instruction with not less than eight hours a week of which two hours will normally be devoted to discussion of principles. This course must include some training in qualitative analysis,

*Thirty weeks are interpreted as a period of a year's instruction exclusive of the examination period at the end of each semester.

if this subject is not covered in the course in general chemistry, or in a separate required course.

3. Physical chemistry (quantitative analysis, a year of general physics, and a year of differential and integral calculus are prerequisites), comprising the equivalent of thirty weeks of instruction with three lectures or recitations a week and three hours of laboratory work. This course should be given in such a way that calculus is used in the treatment of the subject.

4. Organic chemistry, comprising the equivalent of thirty weeks of instruction, with three hours of lectures or recitations a week and five to six hours of laboratory a week. This course should preferably include some qualitative organic analysis unless a special course in this subject is offered, and must include organic preparations work.

5. Advanced chemistry, comprising the equivalent of two lectures or recitations a week for a period of thirty weeks and three to four hours of laboratory a week for fifteen weeks. This advanced chemistry may be in one or more of the following subjects: inorganic chemistry, analytical chemistry, physical chemistry, organic chemistry, biochemistry. Three years of chemistry must be required for admission to such course or courses. (For example, if biochemistry is offered as an advanced chemistry course, its prerequisite must be three year courses in chemistry, including one year of organic chemistry.)

The minimum training for professional chemists must also include the following:

1. Physics, comprising the equivalent

lent of thirty weeks of instruction with three lectures or recitations a week and three hours of laboratory a week. It is highly desirable that the subject of physics be taught from the mathematical point of view and that a student have more than one year's instruction.

2. Mathematics, comprising the equivalent of two years of college work, which must include one year of differential and integral calculus. This last course must precede the required course in physical chemistry.

3. Foreign languages. A reading knowledge of scientific German is required, and some use and application of it should be made during the study of one or more of the chemistry courses taken during the third or

fourth year of the program. Russian or French is advised as a second language.

4. English. A year of English composition is required. It is desirable that this course include both written and oral reports. Attention should also be given to the English used by the student in his examination papers and in his reports in chemistry courses.

5. Humanities. At least the equivalent of one-half a student's residence time for one year must be devoted to the study of humanities, which may be interpreted as non-specialized courses other than in the physical sciences and mathematics. This is exclusive of the required English and languages.

6. All required courses should be given each year.

Concerning Graduate Training

Pending the report on graduate training by the Committee on Professional Training, the following general requirements are given because of their acceptance by the Council at the Baltimore meeting in April, 1939:

For Master's Degree

Before the master's degree is awarded a student must have met the requirements set forth above for the baccalaureate degree, either at the institution in which he received his undergraduate training or at the institution where he is registered as a graduate.

1. Instruction of graduate grade must be taught by staff members with the doctor's degree in chemistry which was awarded on the basis of graduate studies and thesis, or their equivalent, from an institution recognized for its training in chemistry.

2. A full year of work at the graduate level beyond the bachelor's degree is required. At least one half of this, which may include research, should be in chemistry. A substantial amount of laboratory instruction, which may be included in the course work or may be taken in the form of research, is essential.

For Doctor's Degree

Before the doctor's degree is awarded a student must have met the requirements set forth above for the baccalaureate degree, either at the institution in which he received his undergraduate training or at the institution where he is registered as a graduate.

1. A reading knowledge of German and Russian or French is prescribed in addition to the requirements demanded by the institution in which the

student is registered for graduate work.

2. Direction of thesis work must be restricted to staff members who have demonstrated ability to do independent research of high quality as judged by publication of results in the Journals of the American Chemical Society or their equivalent.

3. Proper laboratory space devoted exclusively to graduate students must be available. Necessary chemicals and special apparatus for research work must be provided.

4. Adequate shop facilities must be available.

5. The library must include the leading scientific journals.

6. The university must satisfy the Committee that the department will be helped financially to the extent that it can meet the above requirements.

R. A. BEEBE

W. A. NOYES, JR.

B. RIFGEL

H. B. WEISER

W. G. YOUNG

S. C. LIND, *Chairman*

E. M. BILLINGS, *Secretary*

June 10, 1947.

New Cottonseed Oil Process

► **PURER**, lighter-colored cottonseed oil and lighter-colored cottonseed meal that is probably better both for industrial purposes and for feeding livestock and poultry result from a new extraction process developed at the Southern Regional Research Laboratory of the U. S. Department of Agriculture in New Orleans. It should bring about better prices for these two important co-products of the cotton industry.

Oil extraction as now practiced involves first heating, then pressing the cottonseed, either in huge hydraulic presses or in more modern continuous-process screw presses. Any kind of pressing process leaves about 6% of the oil in the seed meal, and also releases pigment from certain gland-cells in the seed into both oil and meal, making them darker than necessary.

Researchers at the laboratory discovered that if the seed is finely flaked and then shaken violently in a solvent

mixture a three-fold separation takes place: the oil is taken up by the solvent, the oil-free meal settles to the bottom, and the pigment-containing gland-cells float to the top where they may be skimmed off.

As frequently happens in research, this industrially useful discovery was not made as a result of direct effort to improve the quality of cottonseed oil and meal, but is a by-product of scientific curiosity about the cottonseed pigments. In discovering how to get sufficient quantities of the pigments out of the seed for analysis, the chemists hit upon a better way to obtain high-quality oil and meal.

The coloring matter in the seed, they discovered, is not the one pigment which has been known by the name of gossypol, but a complex of at least 11 related pigments. Now the chemists are at work on them, to see if they have any practical use.

**Principles of Science Can Solve
Human Relationship Problems**

Science and the Art of Living

by DR. C. F. RASSWEILER

In his commencement address to the graduating class of his Alma Mater, the University of Denver, Dr. Rassweiler, vice-president for research and development of the Johns-Manville Corporation, explains how the scientific method can be applied to any field of human endeavor.

► IT HAS BEEN my privilege to spend most of my lifetime working with men who have been applying scientific principles and methods to the solution of very practical problems. These men have not been concerned with abstract science or with such fundamental problems as relativity and atomic fission. They have been trying to make white houses stay white and attractive instead of getting dirty. They have been trying to stop the rusting of mechanical refrigerators in the thick humid climates along the Gulf Coast. They have been trying to insulate homes to conserve fuel and make people live more comfortably. The methods they have used and the solutions they have found seem at first glance to have little relationship to the facts they learned from text books in universities such as this, but somewhere in their scientific training they developed attitudes of mind and learned methods of investigation and analysis with which they have been able to make revolutionary changes in the everyday mechanics of living. As I have worked with them I have be-

come more and more convinced that these same scientific attitudes and scientific methods of thinking which have been used so successfully to solve the material problems of living should also be applicable to solving our problems of human relationships. It is particularly appropriate that I should express these ideas to you men and women who are just graduating from the University where I learned the scientific principles about which I want to speak.

As a basis for organizing these ideas I have chosen the title, "Science and the Art of Living"; not "Science and the Mechanics of Living" because you are conscious of the possibilities and accomplishments of science in this field every time you pick up a telephone, open your electric refrigerator, or turn on your electric lights. Instead, I want to talk about Science and the Art of Living, which, to me, means science and the art of living with others. There is a growing feeling that we are spending too much time and thought inventing new automobiles, radios, airplanes and atom bombs and not spending enough time and thought on the solution of the human problems which these new mechanical advances create or intensify. At no time in history have the problems of human relationships been more vital than they are today. The tempo of modern living and the complexities of our highly mechanized civilization constantly complicate the problem of

living happily with our neighbors, while improvements in travel and communications have so shrunk the world that we must think constantly of how to get along happily and peacefully with strange people far overseas. In fact, during the last 30 years science and invention have progressed so rapidly that there is a wide and growing fear that the growth of the machine has outstripped man's ability to control it and that our civilization will eventually destroy itself as scientific advances create problems of human relationships with which we will be unable to cope. I do not share this pessimism, for I believe that the same mental ability that has created these scientific advances can also conceive and create the means for their control. We have seen what scientific methods can do when applied to the mechanics of living. Why not apply the same methods to the art of living and thereby keep our progress in solving the problems of human relationships more nearly in line with our progress in solving our material problems?

Obviously, this cannot be accomplished by the use of chemical reactions or thermodynamics. These are simply means by which scientists accomplish the solution of very specific material problems. Rather, I am thinking of the basic principles and attitudes which make up the scientific method and the scientific approach and which should be applicable in any field of human endeavor. Broadly speaking, science is the gathering and organization of knowledge and the use of this organized knowledge to control the environment and the circumstances surrounding us. This

should be the objective of all education. I am sure that this University would not be graduating you as educated men and women if you had not been trained to gather and organize knowledge, and, much more important, trained to put that organized knowledge to use. There are certain principles which are common to the organization and use of knowledge in every field, but it is in the so-called physical sciences that these principles have been most closely followed. The strict discipline of modern experimentation in the physical sciences has molded and sharpened these principles to the point where they have become the powerful tools that have been used to enable scientists in these fields to achieve such spectacular control over our physical surroundings. As a result, they have come to be spoken of as the "scientific method." I have seen this combination of attitudes, principles and practices applied to the solution of so many practical material problems that I am sure they can be applied with equal effectiveness to the practical human problems of our daily relationships with our neighbors and associates and also to those tremendously complicated problems of our relationships with other nations around the world.

My only hesitation in choosing this subject today is that these principles are so simple and obvious that, at first thought, they hardly seem worthy of being made the basis of a commencement address, but the closer you come to great and complex problems and the better you become acquainted with the men who are facing the solution of these problems, the more convinced one becomes that the greater the prob-

lem, the more simple and fundamental must be the principles applied to its solution. So I am going to talk to you today about simple fundamental things, not because they are new but in the hope that I can bring home to you the fact that the tremendous accomplishments of science are achieved by the conscious and disciplined application of these simple principles that we all know but so few of us practice. If, some day, you should rise to the point where the happiness and welfare of thousands and perhaps millions of people depend upon the soundness of your judgment, your success or your failure will depend to a large extent upon how well you have disciplined yourself to the application of these simple fundamental principles to the solution of the problems you have faced on your way to success.

What are these simple but fundamental scientific attitudes and principles which guided Aristotle in his observations of nature and Archimedes in his experiments in mechanics and mathematics just as truly as they have guided the thousands of scientists along the path to the control of atomic energy? I have a 15-year-old son who is studying elementary science in high school and the other day his teacher confined one of the month's most important examinations to the contents of one single page. This page was headed "Scientific Attitudes" and, as he and I studied them together, I came to feel that much of what I wanted to say to you was summarized on that one page of an elementary science textbook, for the attitudes listed summarized the most important things any scientist secures from his education. But a scientific education does

not consist of simply learning these principles, for a high school boy could memorize them in half an hour. A scientific education consists of learning how to use these principles and in the discipline of doing it every day and every hour until they become instinctive to the point where every decision and every action of the scientist is guided by the conscious or unconscious application of these principles to the particular problem at hand.

Natural Causes

The first of these principles is the conviction that every occurrence, no matter how mysterious, has a natural and understandable cause and that by discovering these causes one can make these occurrences happen or prevent them from happening at will. How simple and obvious when we state it, and yet, for how many centuries people sought refuge in myths and fables and even today are willing to depend on luck and charms and intuition. Modern science became possible only as men shook off this mental drug and became convinced that every time they saw an occurrence happen there was some factor causing it and that with patience and observation and hard work they could eventually discover and understand that cause and, understanding the cause, they could then control that occurrence for their own benefit. Only thus can man control his own future. The principle is simple but the application is hard for one must have a very deep curiosity about these causes to carry one through the long and frequently discouraging task of uncovering them.

One may argue that the causes governing human behavior are too com-

plicated to be analyzed and controlled as the chemist and the physicist and the biologist analyze and control the factors which cause physical phenomena. But this is the counsel of despair. Certainly the problems of physical science have been tremendous and complex. The complexity of the problems faced in releasing and controlling atomic energy, for example, seemed so tremendous only a few short years ago that even a large percentage of the scientists considered material progress impossible except over long periods of time. But the complexity of these problems in physical science have simply meant that they could only be solved as the scientific method was first worked out and applied to the simpler phases that led to the central problem. Perhaps our lack of progress in finding and controlling the causes of human behavior has been our unwillingness to discipline ourselves to the search for the causes and the methods of controlling the simpler elements of human behavior and thus gaining the ability to analyze and solve the more complex problems. Are we willing to discipline ourselves to seriously and honestly seek for the causes of the day-to-day friction with our associates? It takes courage because sometimes the cause lies within ourselves and the control lies in our forgoing certain actions or certain habits which have become easy or pleasant to us though irritating to our associates. When your friend's face lights up at something you have said or done, do you seek the cause for his pleasure so that you can make him happy again later? It is so easy to blame a neighborhood quarrel on your neighbor's bad temper or bad ancestry

and frequently so difficult and so painful to sit down like the scientist and force yourself to face a checklist of the causes which may lie behind the hard feelings. Yet only in that way can you do your share as an educated man or woman toward preserving neighborhood peace, and preserving the peace of the world is only an expansion of the problem of preserving the peace of the neighborhood. It is so easy to worry about possible war with Russia and so difficult to persuade ourselves to sit down and read a book or even a serious magazine article on the causes for the friction which may plunge us into that war. Yet it is only as educated men and women are willing to make the effort to seek and weigh the causes of international friction that we can hope to build up in this country the mass public opinion which is necessary to guide and support the foreign policy that will preserve world peace.

Convincing Proof

The second fundamental scientific attitude is respect for facts and an unwillingness to accept any statement or claim as fact unless it is supported by sound and convincing proof. Certainly this attitude should be an object of all education and part of your training here has been in how to distinguish between those statements and those claims which you cannot safely use as a basis for judgment and action. The tremendous growth of the physical sciences in the last hundred years is based upon what is called the "experimental method", and the experimental method is simply the outgrowth of the realization that facts must be determined and to determine

them we must either observe them in nature or we must artificially create the conditions which will enable us to observe them. Until the facts surrounding a problem have been determined it is useless to try to find a solution. You may argue about the course of action that should be followed based on a certain recognized set of facts but it is futile to argue about the facts themselves. If two scientists cannot agree, the first thing they do is to make sure that they are both basing their arguments on the same set of facts. If they don't have the same facts from which to start, the argument is futile and they try to determine by observation or further experiment which set of facts is correct. How many hard feelings we would avoid and how much smoother our relations with others would be if we were to follow a similar practice in our arguments about the course of human conduct. Too often we are not even careful to define the terms we are using with sufficient clarity and we find out after hours of futile wrangling that we have been using the same name for two entirely different things.

Another aspect of this scientific respect for facts is the realization that you cannot compromise about facts. You may compromise regarding the course of action you will take based upon certain facts but you cannot compromise regarding the facts themselves. If you cannot agree as to whether the cat is black or white, you can be sure that you will be wrong if you compromise and decide that the cat is gray. If the fact of her color has an important bearing on the decision you are about to make, you had better

go out and look at the cat even though this may involve the painful job of digging her out from under the woodshed. You may argue that scientists do compromise on facts when they take the average of a number of observations or average statistics for the purposes of calculation, but this is not really compromising because the scientist realizes that the average is useless and confusing if the differences between the extreme values observed is sufficiently great so that a conclusion based on one extreme would be upset if the other extreme observation should happen to be the correct one. It is the unwillingness to compromise about facts which gives the scientist the reputation for being stubborn and unyielding even though his whole training has been to surrender an old conclusion and accept a new one if new and sound facts become available. One must know when to stand fast and when to compromise in everyday life and one of the best guides is to determine whether the compromise concerns facts themselves or whether it concerns simply a compromise regarding what course of action should be followed after consideration of the facts.

Still another aspect of the scientist's high regard for facts is his unwillingness to state as a fact anything which he cannot thoroughly substantiate by proper proof. How many of our neighborhood difficulties are due to the easy habit of restating a rumor as an established fact. As educated people your statements are going to be accepted by your friends and associates and used by them as a basis for their actions. We each have a responsibility for constantly checking the temptation to

seem big and important by stating as known facts things for which we do not have a real sound basis of knowledge. Or, if the circumstances justify our stating things for which we do not have full proof, we have a responsibility for simultaneously stating the degree of inexactness or lack of knowledge which should be considered before our statement is used as a basis for decision or action. The scientist learns to calculate the probable error in every observation and he recognizes that the usefulness of a fact and the extent to which it can be used in forming a conclusion depends upon its exactness and is limited by the possible error involved in its determination. The scientist, in striving to convey the limits on the exactness of his statements is often accused of using "weasel words" and of being unwilling to commit himself definitely, but we would be much better off if we were to constantly face a true realization of the degree of accuracy or lack of accuracy in our knowledge regarding the facts which control human behavior rather than being too dogmatic about the accuracy of the data upon which we frequently have to base our actions.

Study the Facts

The third scientific attitude is the determination to marshal and study all of the facts relating to a given problem, discarding those which are not relevant, examining the reasonableness of those that remain, and determining whether there are enough facts to justify a conclusion. Again, the principle is easy but the application is hard. There are so many facts that must be examined and considered.

One of the principal objects of your education here at the University has been to open up to you the tremendous storehouse of facts which have been accumulated through the centuries by educated men and women for you to use as the basis of deciding your actions and controlling your future. No element in a scientist's training is more difficult to instil or more painful in practice than the determination to study all of the facts available in the literature and from his associates before undertaking a course of action or experimentation. Yet nothing is more wasteful or more embarrassing than to undertake a course of action and find after painful work that its hopelessness could have been accurately predicted if one had taken time to study all of the facts that had been available before the work was started.

But when one has collected all the available facts he almost always has too many or too few. Someone has pointed out that study of arithmetic in school is made too easy because the ordinary problem states all the facts that are necessary for the solution and no more. Actual life is never this simple. The solution is always either confused by irrelevant facts which must be discarded or made impossible by the unavailability of all the facts necessary for a solution. A great deal of confusion and fuzzy thinking comes from trying to consider a great many facts which are either totally irrelevant or have only minor importance in connection with the decision to be reached. One of the major characteristics of a successful leader or a successful executive is the ability to brush aside the facts of minor consequence and recognize the two or three

vital facts upon which a decision must be based. On the other hand, a great deal of our uncertainty about important decisions is due to our failure to realize that we do not have all the facts which must be determined before we can safely decide on a course of action.

Having collected all the facts available and discarding those which are irrelevant, the scientist next attempts to judge the reasonableness of those that remain. Every man and woman has a right and a duty in judging the reasonableness of facts, even though they may lie in the fields where he or she is not possessed of specialized knowledge. Democracy itself is based upon the fundamental belief that every man and woman has the ability to judge whether facts or proposals are reasonable or not. If we lose confidence in our ability to do this and come to depend blindly upon the opinions of experts without weighing these opinions against our own background of experience, then, indeed, democracy will die in this country. Even in science where conclusions are supposed to be the results of exact experiment and exacting logic, the scientist looks at the final result and asks himself, "Is this conclusion reasonable?". One of the outstanding characteristics of leaders in industry, science, or government is the ability to judge the reasonableness of facts presented by men who are more expert in a particular specialized field than the leader himself, for only in this way can the leader truly carry the responsibility for deciding on the course of action either for his company or his country.

Without Prejudice

The next scientific attitude is a respect for the evidence and the viewpoint of others and a determination not to let a conclusion be swayed by one's own personal prejudices or wishes. A true scientist is anxious and willing to do his own experimenting, determine his own facts, and reach his own conclusions, but the competition of modern science and the penalties for inaccuracy are too great to permit a man either to depend entirely upon the things he himself can determine or to allow himself the luxury of permitting his conclusions to be swayed by what he wishes to be true. In particular, scientific progress has been greatly facilitated by the recognition that there is always more than one way of looking at a specific problem and that it is usually much more important to try to understand the other man's viewpoint than it is to expound your own. The scientist will frequently argue long and hard for the superiority of his own viewpoint but he has found it safest to do so after thoroughly understanding what the other man's viewpoint is. This is even more important in connection with human problems than it is in science for life has many facets and we cannot safely view it from only one angle.

Accept New Evidence

The fifth and one of the most important of the scientific attitudes is a willingness to change one's opinion in the face of new evidence and new facts and the belief that, while truth itself is unchanging, our understanding of it and our interpretation of it change as we gain new knowledge. Mr. Kettering, the famous head of re-

search for General Motors, once told a group of scientists that the most important skill which the automobile companies brought to the problem of national defense and the prosecution of the last war was not skill in working metal and making engines but skill in the technique and psychology of change. How much time is lost and how many worthwhile projects fail because people are unwilling or unable to change their opinions or their course of action as new evidence and new facts become available. Science emphasizes the importance of that flexibility of thinking which tests each new fact and each new idea against the background of past knowledge and then accepts that which is best and rejects that which is outmoded even though this involves acknowledging prior error.

One of the greatest causes for failure to properly adjust our thinking in science and every-day life to new facts is our dependence upon generalization or rules which have become established by usage even though they may have originally been based upon very slender evidence. A successful scientist must continually re-study the facts upon which his general opinions are based for frequently he will find that the generalization, although the best interpretation of the facts available when it was made, is no longer sound in the light of the greater information available today. The more complicated science has become, the more scientists have come to depend upon generalizations and this dependence has become so dangerous and has sometimes been so restrictive on the adoption of new ideas that it has been said that genius is the ability to disregard preconceived

ideas. There must be rules and generalizations to guide our thinking, but let us avoid depending upon them so blindly that they become shackles upon our ability to progress.

This scientific attitude leads to a great deal of uneasiness on the part of non-scientific people who do not understand that, while the scientist is always seeking new facts, he does have a belief that truth itself is unchanging and that all that changes is our understanding and interpretation of the great truth which we are constantly trying to understand better. It is this firm and unchanging belief in the permanence and the orderliness of fundamental truth that has made great philosophers scientists and great scientists philosophers. The late Dr. W. A. Noyes, one of the great organic chemists of his day as well as a deep and reverent philosophical thinker, used to explain to his classes in the history of chemistry how something can be scientific truth today and still be completely disproved tomorrow, for scientific truth is simply our best interpretation of the facts we have now. He used to say that one should never look with derision upon what our predecessors used to think was true even though we now had available facts which permitted us to make a better interpretation and that we should never be apologetic or fail to use our best present interpretation of the truth today even though we used it with the full knowledge that tomorrow, God willing, we would know more and be able to interpret it better. This deep and abiding faith in the fundamental constancy of truth and a constantly growing realization of the tremendous complexity and yet the beautiful orderliness of

this truth is the thing that has made so many of our great scientists also deeply religious. A similar confidence in the importance and unchangeability of fundamental truth and an equally sincere striving to understand it on the part of all educated people should give point and reason to what might otherwise seem a futile and confused struggle for survival.

Follow a Plan

The last and final scientific attitude is a determination not to proceed blindly but to plan and to follow the course indicated by the best available information. Again, a simple practical matter of common sense, but one which even the most scientific of us so frequently disregard. It is so easy to let our actions be guided by the circumstances of the moment just as it is easy for the scientist to be attracted away from his major purpose by intriguing side possibilities. Yet we must each one of us have a plan and an objective and we must each one of us follow it, not blindly, but with constant alertness for the signposts and the indications which will guide us to our destination. Dr. Carruthers did this when he started with the determination to find the relationship between molecular structure and the strength of organic fibers and he followed that path unswervingly until it led him eventually to the discovery of nylon. How many of our problems of human relationship would be solved if, as individuals or as nations, we planned as definitely and followed as religiously a course directed toward our obvious objective.

So there they are—six basic fundamental scientific attitudes. First, a belief that every occurrence, no matter

how mysterious, has a natural and understandable cause, and that with sufficient observation and work we can understand that cause and thereby control the occurrence for our own benefit. Second, a fundamental respect for facts and an unwillingness to accept or state a thing as being a fact unless it can be supported by sound and convincing proof. Third, a determination to marshal and study all the facts relating to a given problem, discarding those which are not relevant, examining the reasonableness of those that remain, and determining whether there are enough facts to justify a conclusion. Fourth, a respect for the evidence and viewpoint of others and a determination not to allow one's conclusions to be swayed by prejudices or what he himself wishes were true. Fifth, a willingness to change one's opinion in the face of new evidence and new facts and the belief that, while truth itself is unchanging, our understanding of it and our interpretation of it change as we gain new knowledge. And finally, a determination not to proceed blindly but to plan and follow the course indicated by the best available information. Six principles, simple as all really fundamental principles must be; simple enough, in fact, for a high school boy's elementary textbook, yet fundamental enough to have been the guiding principles of science throughout the ages. These principles, sharpened and molded by the discipline of experimental physical sciences, have become so effective that they have made it possible for us to project our voices around the world, travel at the speed of sound, and use the energy of the atom to destroy cities or to build great industries. They

are not the property of the scientist alone, but properly the creed and the principles of every educated man and woman. Scientists have used these principles to control our physical surroundings. With them they have performed miracles in improving the mechanics of living. Cannot we also use them as tools to improve the art of living to help us to organize our

knowledge about human beings and the causes of human behavior so that we can use this knowledge in order to live with our neighbors down the street and our neighbors across the sea happily, prosperously, and peacefully? Man has learned to control his physical environment. Surely he can use the same means to control his ultimate destiny.

Cortin for Mental Health

► A GLAND discovery has given a new lead to the mental disease problem.

Dr. Hudson Hoagland, Dr. Gregory Pincus and Fred Elmadjian of the Worcester Foundation for Experimental Biology, Worcester, Mass., have found that, in the mentally sick, the adrenal glands respond to stress in a way strikingly different from their response to stress in normal persons. The adrenals are small organs that sit like cocked hats one atop each kidney. They produce two hormones, epinephrine, also called adrenalin, and cortin. The cortin-producing part of the gland, which is not under nervous control, is the part that responds differently under stress.

A count of certain white blood cells called lymphocytes gives one measure of the activity of the cortin-producing part of the adrenals. In normal persons, operation of a pursuitmeter under simulated high altitude flying conditions may drop the lymphocytes 40 per cent. A rise of like amount on the average occurs in mentally sick patients when operating the pursuitmeter under the same conditions. The amount of stress this operation involves has been called by Army pilots

as tiring as close formation flying under poor weather conditions.

The mentally sick are persons who have broken psychologically under the stresses of life. It now appears that the functioning of certain glands in the mentally sick is inadequate to meet stress situations. Whether the gland failure is responsible for the mental sickness has not yet been determined, but scientists have long been searching for such a physiological failure to explain the psychological break.

More successful treatment of mental sickness might follow the important lead which the Worcester discovery gives. At present the scientists are trying to localize the mechanism responsible for the gland failure. It may be in any of three places: 1. the outer part, or cortex of the adrenal gland which produces cortin; 2. the pituitary gland in the head which normally stimulates the adrenal glands to produce cortin; 3. the hypothalamus in the base of the brain which controls the pituitary gland. Since the hypothalamus is intimately related to emotional life, a defect in it could have widespread repercussions in both the mind and body of the patient.

**Disease Viruses "Evolve"
Like Plants and Animals**

Mutants on Borderline of Life

► VIRUSES of maladies like smallpox, yellow fever, foot-and-mouth disease and the mosaic diseases of tobacco and other plants undergo mutations or abrupt changes in their chemistry that are analogous to the mutations or sudden evolutionary changes known to occur in bacteria, as well as in larger plants and in animals. A mild ailment might thus become a ravaging epidemic, or contrariwise, a virulent disease may be partly denatured and used in producing immunity in men and animals.

The dramatic possibilities for both good and ill latent in this situation were enlarged upon in an address by Dr. W. M. Stanley, Nobel prize winner on the staff of the Rockefeller Institute for Medical Research, given before the Chicago section of the American Chemical Society, on the occasion of the presentation to him of the Willard Gibbs Medal, one of the most coveted honors in American science.

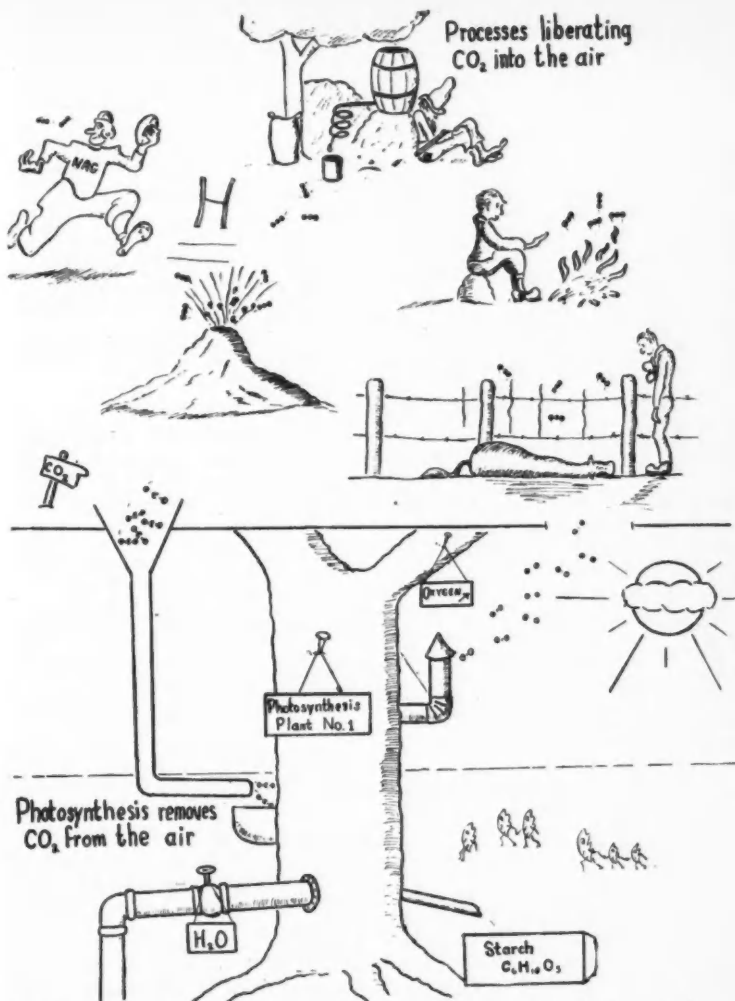
Viruses are disease-causing substances that are usually thought of as on the borderline between the living and the non-living. They can feed and breed, as plants and animals do; yet some of them can be reduced to crystalline form, which is an attribute of non-living chemical compounds. Their individual particles, which may be separate molecules, range in size from larger than some of the smaller bacteria down to smaller than some

known protein molecules. Dr. Stanley showed electron microscope pictures of several types of viruses.

First known mutation of a virus, Dr. Stanley pointed out, was the modification of smallpox into cowpox when cows "caught" the human disease. This chance mutation is the source of the material used in vaccination. A somewhat more deliberately produced mutation was the amelioration of yellow fever virus, by growing it on tissue cultures, until it has lost most of its virulence.

A change in the other direction was spontaneously taken by a strain of tobacco mosaic virus, Dr. Stanley stated. Ordinarily, this disease makes tobacco plants sick but does not kill them. The mutated strain, however, will kill every young tobacco plant exposed to it. Dr. Stanley suggested that some of the plagues that sweep the earth and then disappear, like the 1918 pandemic of influenza, may have been due to such virus mutations.

Since viruses are, in some aspects at least, complex chemical compounds, Dr. Stanley and his associates have experimented with the intentional production of mutations by chemical treatment of certain tobacco mosaic strains. Thus far, however, the modified viruses have reverted to type when re-inoculated into tobacco plants. Further experiments along this line are still in progress.



► JAMES FIELD, high school senior at the Lew Wallace School, Gary, Indiana, drew these clever illustrations of the carbon dioxide cycle. His teacher, Miss Helen S. Mackenzie, sent them along to us for the entertainment (and instruction) of other chemists.

For the Home Lab

Anesthesia

by BURTON L. HAWK

► IT HAS BEEN SAID that the first operation with anesthesia was performed upon Adam in the Garden of Eden:

"And the Lord God caused a deep sleep to fall upon Adam, and he slept: and He took one of his ribs, and closed up the flesh instead thereof. . . ." (Genesis 2:21).

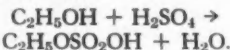
Despite this indication of antiquity, our modern practice of anesthesia with anesthetics is of fairly recent origin. Not too many years ago in order to undergo an operation the patient was simply tied securely to a table and forced to bear the severe pain, being conscious during the entire procedure.

Perhaps the first anesthetic to be recognized as such was nitrous oxide, when Sir Humphrey Davy first observed that it was "capable of destroying physical pain." In 1844 it was employed as an anesthetic in dentistry by Horace Wells of Hartford, Conn. However it was not entirely successful, and when a death resulted from its use, Wells was forced to abandon Nitrous Oxide as an anesthetic.

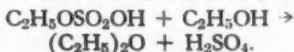
Ether was first used for anesthesia in dental surgery by Dr. William Morton, a friend of Wells, (1846). He was so pleased with the result, that he immediately urged its use for other types of surgical operations. In a demonstrative operation, he finally succeeded in convincing skeptical doctors of its value as an anesthetic.

Ether

The preparation of ether is one of the oldest of organic reactions. It is formed readily by heating together equal quantities of ethyl alcohol and sulfuric acid. Place about 10 drops of each liquid in a test tube. Warm gently for a few moments and you will soon be able to recognize the familiar odor of the ether.



This then reacts further with alcohol to form ether and sulfuric acid:



Commercially, the mixture is distilled at a temperature of 130° C., and since the sulfuric acid is regenerated, only alcohol is added from time to time. In this way a small quantity of sulfuric acid is utilized in converting large quantities of alcohol into ether.

Great care must be used in distilling ether. Not only is the liquid readily inflammable, but its vapor forms with air a heavy and highly explosive mixture. This mixture is capable of drifting considerable distances and of still exploding upon contact with an open flame.

Chloroform

Soon after the introduction of ether as an anesthetic, chloroform was discovered to have similar properties and was also used in anesthesia. Although it has an advantage of not burning or

exploding, chloroform is not as safe as ether because of poisonous effects. On exposure to light and air, chloroform undergoes oxidation forming the poisonous phosgene. This can be prevented by the addition of alcohol which converts the phosgene into harmless diethyl carbonate.

To prepare chloroform, place 5 grams of bleaching powder in a flask. Add 20 cc. of water and stir the mixture. Mix together 1 cc. of acetone with 3 cc. of water and add in small portions to the mixture in the flask. Shake the flask thoroughly after each addition. When all has been added, connect a stopper and tube to the flask. Lead the tube to a vessel externally cooled. Warm the flask gently. Chloroform will distill over and condense in the receiving vessel. It boils at 61° . You will no doubt recognize its characteristic sweetish odor.

Chloroform can also be formed by reducing carbon tetrachloride with nascent hydrogen.

Other Anesthetics

Now, if you haven't put yourself to sleep yet, we will briefly discuss a few other anesthetics.

Cocaine—First used for local anesthesia in 1879. It is found in coca leaves and is now used as the hydrochloride, $C_{17}H_{21}O_4N \cdot HCl$. Since it is habit-forming and somewhat toxic, its use is being replaced by other drugs.

Novocaine—(*Procaine Hydrochloride*)—A synthetic drug used in place of cocaine as it is less toxic, $C_{13}H_{20}O_2N_2 \cdot HCl$. Prepared by esterifying *p*-nitrobenzoic acid with diethylaminoethanol and reducing.

Ethylene— C_2H_4 , used as inhalation anesthetic. Almost devoid of unpleasant after-effects.

Ethylene Dichloride— $CH_2Cl \cdot CH_2Cl$, can be used as chloroform, but is somewhat dangerous.

Ideal Properties

Ether is still the most widely used anesthetic despite some disadvantages. Perhaps some day some one will discover a new anesthetic—one which will not burn or explode, have no irritating fumes or obnoxious odor, be easily administered with no unpleasant after-effects, safe, cheap and readily available. Here is a challenge to a future scientist!

Stingless Tincture of Iodine

► PHARMACISTS are taking the sting out of tincture of iodine, a famous disinfectant for cuts for more than a century.

The new edition of the Pharmacopoeia of the United States of America which became official April 1 has dropped the familiar 7% tincture of iodine in favor of a 2% mild tincture. Just as efficient as an antiseptic

and germicide, the milder tincture has the advantage of not retarding healing by destroying tissue, a frequent fault of the stronger remedy.

The Committee of Revision of the Pharmacopoeia declares, "Every druggist in the country should be familiar with this change." You will agree if you recall the sting of the old iodine disinfectant.

Nitrogen Fixed by New Process

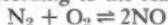
by FREDERICK G. COTTRELL

The inventor of the Cottrell precipitation process, in this specification for a new patent, makes the startling statement that present methods of nitrogen fixation waste 97% of the energy supplied. He explains his principle of fixation by thermal energy alone, which depends on rapid cooling of nitrogen oxide formed by heating oxygen-enriched air.

Process of Producing Nitric Oxide

Frederick G. Cottrell, Washington, D. C., assignor to Wisconsin Alumni Research Foundation, Madison, Wis., a corporation of Wisconsin. U. S. Patent No. 2,422,081; June 10, 1947.

➤ THIS INVENTION relates to an improved process of and definitive apparatus for effectuating technically important gas reactions progressing favorably at elevated temperatures with the absorption of considerable amounts of heat. It is concerned particularly with the conversion of molecular oxygen and nitrogen into nitric oxide (NO), according to the reaction;



The formation of nitric oxide from its elements is endothermic, absorbing 46,720 cal./mol. of N_2 (1400 B. t. u./lb.) and exhibits equilibrium concentrations of NO from fractional percentages to 7% in the temperature range from 2500° F. to 5000° F. The heat of formation of nitric oxide is small — 2,800,000 B. t. u./net ton,

which is equivalent to the heat of combustion of 0.47 barrel of fuel oil or of 200 pounds of coal.

The fixation of atmospheric nitrogen in the form of NO at elevated temperatures has long been known. The process has generally been thought of in connection with the electric arc, and has been associated with the consumption of considerable quantities of electric energy. As a matter of fact, the cost of the energy usefully employed in such arc processes has not been particularly high, i. e., 822 kw. h./net ton of NO. Although the cost of this usefully employed electrical energy may be four to five times the cost of the same fuel energy, the technical importance of the difference in cost is not great. It is the energy which is actually consumed in those arc furnaces heretofore employed which has limited the commercial development of this thermal process; the energy introduced in the commercial arc process has ranged from 67,000 to 75,000 kw.h./ton of nitrogen fixed. This amount of energy is some forty times as great as that required by Reaction 1. About 97% of the energy supplied obviously has been wasted merely in heating the unreacted air to arc temperatures and less than 3% has been utilized in supplying the energy actually absorbed in nitric oxide formation.

It was realized early in the development of the arc process that some effective means would be needed to re-

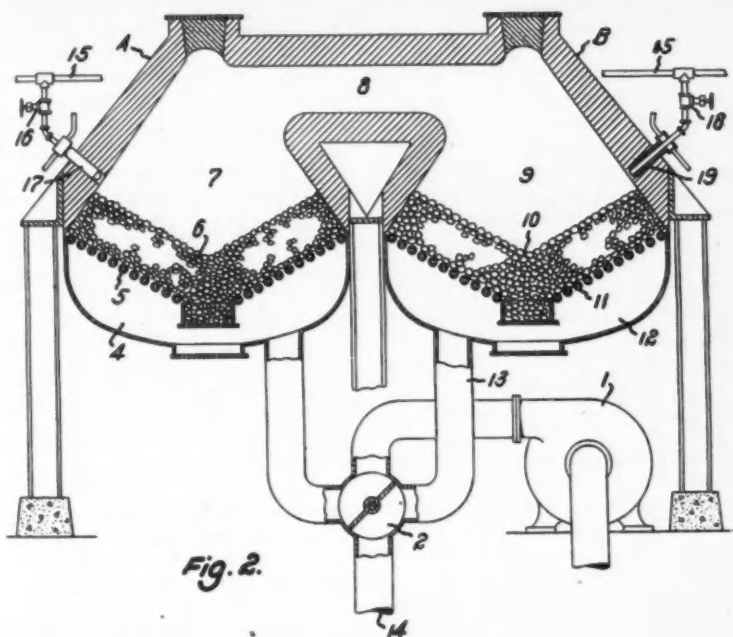


Fig. 2.

► *HEAT TRANSFER beds designed to cool nitrogen oxide so fast that it does not have a chance to decompose. (One of the drawings in the Cottrell patent).*

cover a substantial portion of the sensible heat of the unreacted oxygen-nitrogen gases discharged from the reaction zone if the process were to be made industrially competitive except where electric power was abnormally cheap. With this object in view it has been proposed to employ, in conjunction with arc furnaces, regenerators of the type commonly used in blast furnace stoves, open hearth steel furnaces, glass melting tanks, and the like. Unfortunately, the rate at which Reaction 1 progresses both from right to left and from left to right at the temperatures heretofore employed is

so rapid that the greater part of the NO formed in the reaction zone would have been decomposed during the process of cooling the reacted gases down to ordinary temperature. In any process for the thermal fixation of atmospheric nitrogen as nitric oxide after the high temperature reaction has progressed to a near approach to equilibrium prevention (as far as possible) of progress of Reaction 1 from right to left during the ensuing cooling of the highly heated gaseous reaction mixture requires that at least over the first few hundred degrees such cooling shall be effected

with great rapidity. In many of the actual operations contemplated in the industrial application of the present invention, it is desirable to "quench" or "chill" the reacted gas mixture at rates of cooling ranging from one thousand to a million or more degrees Fahrenheit per second. No such cooling rates, of course, can be carried out in the types of regenerative heat exchangers heretofore employed or suggested for this purpose.

In order to prevent the loss of large fractions of the nitric oxide formed at the furnace temperature, rapid "quenching" is a fundamental necessity. In order to make a reasonable approach to commercially acceptable thermal efficiencies, this rapid quenching must be accomplished without materially increasing the entropy of the system; that is to say, unless the transfer of heat from the effluent gases to the thermal interceptor is carried out with a reasonable approach to isothermal equilibrium, i. e., Second Law efficiency, the heat recovery is irreversible, and cannot be restored to the process by any possible form of recuperator or regenerator.

It is an object of the present invention to provide operative means for the production of nitric oxide at a reduction in cost as compared with the commercially employed prior art processes for the fixation of atmospheric nitrogen as NO.

By the methods of the present invention it is possible to carry out Reaction 1 with percentage efficiencies in the high eighties and nineties. The attainment of such unusual efficiencies is possible through the agency of the highly efficient thermal regenerators herein contemplated. These regenera-

tors exhibit not only a high recovery of heat but as a more important feature recover heat with close approach to thermodynamic reversibility.

According to the present invention, fixation of atmospheric nitrogen as nitric oxide is effected by passing a stream of gas consisting essentially of nitrogen and oxygen, e. g., atmospheric air, or, preferably, an equimolar mixture of nitrogen and oxygen, through the interstices of an assemblage of solid particles of heat-exchanging material (hereinafter more fully described), heated in prior operation to well above 3600° F., whereby the gas is heated to reaction temperature and substantial amounts of NO are formed, and thereafter causing the reacted gas to traverse a second, similar, assemblage of heat-exchanging material in which a gradient of temperature negative with respect to the flow of the gas has been established by prior operation, whereby the gas is rapidly chilled to a lower temperature at which decomposition of NO is negligibly slow. As this described process continues, heat is removed from the first or up-stream regenerator and is transferred to the passing gas stream—substantially all of this transferred heat, except for heat lost through the walls of the apparatus, for heat contained in the exhaust gas and for the heat usefully employed in nitric oxide formation, is re-transferred by the gas to the second or "downstream" regenerator. That is to say, the isotherms in both regenerators are displaced in the direction of gas flow, causing the temperature of the exhaust gases from the down-stream regenerator to rise progressively during this operation.

To prevent excessive heat loss in the exhaust, the direction of flow of the gas through the apparatus is reversed at suitable intervals. The continuous small depletion of heat in the apparatus (due to nitric oxide formation and to loss of heat through the walls and in the exhaust gas) is recompensed by introducing thermal energy into the reaction zone in any convenient form, e. g., as fuel gas, fuel oil, powdered coal, electric energy, or the like. This energy may be introduced either continuously throughout the operation or intermittently as a separate operative step.

The thermal regenerator employed in the present process preferably consists in a chaotically assembled mass of relatively small refractory heat-exchanging particles, e. g., sized and screened particles of common refractory oxides such as Al_2O_3 , Cr_2O_3 , ZrO_2 , $ZrO_2 \cdot SiO_2$, CaO , MgO , $MgO \cdot Al_2O_3$ (spinel), and the like. Such masses of heat-exchanging particles are readily traversable by the gases entering and leaving the reaction zone. The interstitial spaces between the refractory particles in the bed constitute fluid channels of small "mean hydraulic radius" (M. H. R.), and exhibit a consequent high coefficient of heat transfer. The tortuous path provided, for the flow of gas, by the

geometric configuration of the interstices adds to the turbulence obtaining in the gas stream, thereby increasing the intimacy of thermal contact at the gas-solid interface. Because of the close approach to reversibility attainable, more than eighty per cent of the heat carried from the reaction zone by the exhausting gas can be restored to the process as preheat of the incoming air, with resulting realization of agreeably high over-all efficiency. Reference is made, in this connection, to the employment, in the carrying out of the process of the present invention, of principles of the "Royster pebble stove" as described in Reissue Patent No. 19,757, certain applications of which are further described in my Patent No. 2,121,733.

It is a fortunate circumstance that this type of thermal regenerator exhibits these two concurrent characteristics of high reversability and rapid quenching rates. Without rapid chilling, a large part of the nitric oxide formed is lost through decomposition. Without high reversability, a large part of the heat is lost from the system. Both these requirements must be met in a single apparatus in order to permit technically feasible and, at the same time, economically successful fixation of atmospheric nitrogen.

Quartz-free and low-quartz materials, substituted for sand to increase locomotive traction in mines, are expected to decrease the amount of silicosis, a lung disease, among miners.

Long fingernails are not permitted in many ammunition factories because they may cause explosions, as certain detonators are sensitive to friction.

The stinging nettle, a weed is a potential source of commercial chlorophyll.

Hints for Your Lab

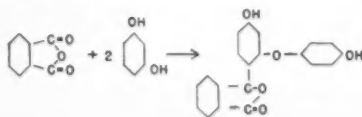
It Shines in the Dark

Descriptions of equipment which you have built for your lab and directions for preparations which you have enjoyed making are acceptable for this department. Two dollars will be paid for each Hint published. Contributions should be typewritten on one side of the paper, double spaced. Drawings of apparatus should be in India ink, or in pencil lines without shading. Address Hints Editor, Chemistry, 1719 N St., N.W., Washington 6, D. C.

Fun With Fluorescein

► FLUORESCIN ($C_{20}(OH)_2O_3$) is in itself of little commercial importance. Its sodium salt uranin on the other hand has been responsible for the lives of over one-third of our airmen rescued at sea during the war. Uranin dye is so powerful that one pound of it will color more than an acre of ocean water.

You may easily prepare fluorescein and demonstrate its unusual properties in your home lab. Simply heat together one mol. (7 grams) of phthalic anhydride, and two mols. (ten grams) of resorcinol in a beaker or porcelain evaporating dish. The following reaction takes place:



Your druggist can supply you with resorcinol, the phthalic anhydride may be purchased from a chemical supply house. When the dark red mass becomes syrupy, heating is discontinued and the product is cooled, broken up, and washed several times with any dilute acid. The product is then dried and stored in a bottle. This fluorescein is a red crystalline mass which owes its name to its characteristic fluorescence in solutions. In order to demonstrate this striking property, which enables airmen to spot survivors at sea, place a pinch of the dye in a flask and add to it a small piece of sodium hydroxide. When held to the light beautiful green-yellow fluorescent clouds may be seen arising from the dye.

Another interesting experiment is making luminous paint. Put a tablespoon of powdered boric acid in a discarded metal bottle lid. Add a small piece of fluorescein and a piece of sodium hydroxide half the size of a pea. Slowly heat this mixture till it fuses into a glassy plastic, and then rapidly cool it by setting the container in cold water, being careful not to wet the crystals. Expose this powder to the light and bring it into the dark. The amount of light emitted is surprising. A printed page may be read clearly for several seconds by the light from fluorescein which has been exposed to direct sunlight. By powdering the glassy mass and adding shellac, you have a good luminous paint.

ALLYN F. ROBERTS

Many Chemical Processes Appear in New Patents

Chemical Ways to Do Things

Specifications of patents granted may be purchased from the Commissioner of Patents, Washington 25, D. C. for twenty-five cents each (not stamps). Order by patent number.

Food Dehydration

➤ **VEGETABLES** can be dehydrated more rapidly and keep their appearance and flavor better if treated with a combination of radiant heat from electric elements and a current of very dry, very hot air or other gas at the same time, claims Clarence Birdseye of Gloucester, Mass., pioneer of the frozen-foods industry who is now entering other fields of food processing. Three new U. S. patents, 2,419,875 to 2,419,877, have been issued to him on this combination, which also includes the use of high-frequency electromagnetic waves.

Two things are necessary during the process, Mr. Birdseye points out: the vegetable slices or dice must be of fairly small dimensions, and they must be kept constantly agitated as they are carried through the dehydrating cabinet on a series of conveyor belts.

Dehydration and quick-freezing are combined in the third patent; it has been found advantageous to remove part of the water from some fruits before freezing them in syrup.

Cu and Ni Hold Fluorine

➤ **MEDIEVAL ALCHEMISTS** seeking for the "universal solvent" were stumped by the question: "But what will you

keep it in if you find it?" Nearest modern relative of this mythical fluid is the gas fluorine, related to chlorine but far more corrosive, which has recently been found exceedingly useful in industry.

The container problem was solved by two Bronxville, N.Y., chemists, Homer F. Priest and Aristid V. Grosse, who found that in cylinders of copper, nickel, or an alloy of both, the fluorine quickly forms a coating of a compound which protects the rest of the metal from further attacks. All valves and other fittings have to be made of the same metal.

The patent, No. 2,419,915, has been assigned to the U. S. government through the Office of Scientific Research and Development.

Amines Aid Oil Wells

➤ **QUINOLINE** or a related amine, dissolved in oil, is pumped down into oil wells dropping in yield because of water-clogged sands. The amines render the sand more wettable by oil, thus restoring the flow. The patent, No. 2,419,755, was granted to F. W. Albaugh of Inglewood, Calif., and assigned the Union Oil Company of California.

Lignin For Textiles

➤ **ANOTHER** possible job for lignin, problem child of the wood industries, is covered by patent 2,419,783, taken out by Kermit Longley of Philadelphia. He reacts a lignin sulfonate with a fatty acid, to prepare

a compound useful as an emulsifier and as a size for finishing textiles.

Barnyard Chemical

► A USE FOR empty eggshells has been found by Mario Contesso of Astoria, N.Y., recipient of patent 2,419,822. After thoroughly cleaning them with hot water and drying them, he grinds them up as a high-purity powdered calcium carbonate.

HF Recovery

► HYDROGEN FLUORIDE used as a catalyst in oil refining is recovered from the spent condition by treatment with superheated steam, in the process on which James D. Gibson of Bartlesville, Okla., has received patent 2,419,558, which is assigned to the Phillips Petroleum Company. The fluorine comes out as hydrofluoric acid, which may be concentrated to the anhydrous condition.

Fuzes and Rockets

► WARLIKE PATENTS continue to be issued, though in diminishing numbers. One interesting invention in this class is covered by patent 2,419,815, granted to G. E. Breeze of Uncasville, Conn., and G. R. F. Gay of Garden City, N.Y. It is a fuze for bombs which functions only when it enters water, because it depends on water to close the electric circuit that arms it.

An aerial torpedo with rocket-like propulsion is the invention of an Englishman, W. G. Wilson of Winchester. It is covered by patent 2,419,866.

Chemical Seamark

► CHEMICALS that create a bright glow when dropped on water, of great possible usefulness to seamen

and trans-ocean flyers, are the subject of patent 2,420,286, issued to three chemists working in the laboratories of the American Cyanamid Company of New York, Dr. H. T. Lacey, H. E. Millson and F. H. Heiss. Among possible uses are marking the surface for a plane making an emergency night landing at sea, giving a "seamark" for navigational purposes for either ships or planes, and showing the location of lifeboats or life-rafts to searching planes in the dark.

A typical formula consists of 3-amino-phthalhydrazide sodium perborate, potassium ferricyanide and trisodium phosphate. The ingredients, ground to fine powder, are mixed dry and preferably formed into tablets or cakes with a binder. Only on contact with water do they react to produce chemiluminescence.

Marihuana-like Drugs Made

► FOUR PATENTS, 2,419,934 through 2,419,937, have been granted to Prof. Roger Adams, head of the chemistry department at the University of Illinois, on a series of synthetic drugs with marihuana-like action, which he states are useful in treatment of narcotic addiction by withdrawal. A typical compound is prepared by condensing pulegone, a derivative of pennyroyal oil, with one of the higher benzenes in the presence of a phosphorus-containing catalyst.

Lactic Acid Extraction

► TWO CHEMISTS of the U. S. Department of Agriculture Regional Research Laboratory at Philadelphia, Edward M. Filachione and Charles H. Fisher, have developed a method of purifying lactic acid, much used in food and beverage industries, out

of the crude fermented mixtures in which it is produced. They bubble alcohol vapor through the liquid; the alcohol picks out the lactic acid and leaves the impurities behind. Later it is separated from the lactic acid, and re-used. Patent 2,420,234, granted on this invention, is assigned royalty-free to the government.

Ore Reduction Speeded

➤ **COKE CONSUMPTION** in blast-furnace operation is cut by blowing in heated carbon monoxide to speed the ore reduction process, in the process on which S. P. Kinney of Crafton, Pa., received patent 2,420,398.

New Dehydrators

➤ **DEHYDRATED FOODS**, usually prepared by one or another type of heating process, are made on a new basis in the process covered by patent 2,420,517, issued to J. D. Brandner and R. M. Goepf, Jr., Atlas Powder Company chemists. They get most of the water out of vegetables and fruits by exposing them to exceedingly "thirsty" compounds, such as some of the sugars, and merely finish the job by evaporation.

Seaweed Jelly

➤ **A NEW KIND** of seaweed jelly, useful in ice creams, confectionary, icings and the like, is the subject of patent 2,420,308, obtained by John I. Gates of Pasadena. It is a mixture of ammonium or sodium alginate with calcium alginate. Patent rights are assigned to the Kelco Company of San Diego.

Toughening Goldenrod Rubber

➤ **THE END** of the war has brought a slacking of interest in goldenrod rubber; but we may have to face a rub-

ber crisis again some day, so F. L. McKennon of New Orleans and J. R. Lindquist of Los Angeles have developed a method for toughening up the soft, tacky rubber of this plant. The rubber and the customary compounding vulcanizing chemicals are mixed after dissolving in benzol; then the benzol is rapidly evaporated out and the rubber mixture heated. Rights in the patent, No. 2,420,788, are assigned royalty-free to the government.

Flame-proofing Fabric

➤ **A NEW METHOD** for flameproofing fabric by impregnating it with a silicate glass of lead or other metal is submitted by L. C. Athy and P. C. Stuft of Baltimore for patent 2,420,644, which they assign to the Pemco Corporation. At flame temperatures the glass melts, protecting the fibers.

Amorphous Carbon From Oil

➤ **AMORPHOUS CARBON**, impalpably fine, sooty-black stuff useful as rubber filler and for pigment purposes, is economically produced from the poorest grades of crude oil by a process on which U. S. patent 2,420,999 has been granted to Joseph W. Ayers of Easton, Pa. The oil is injected as a high-pressure jet into a closed retort, along with a stream of air to produce partial combustion at temperatures ranging from 2,000 to 3,000 degrees Fahrenheit. At the other end, a continuous stream of carbon black is drawn off, collected with an electrostatic precipitator and stored until ready for packaging. Rights in the patent are assigned to the Phillips Petroleum Company.

Soy Bean Cereal

➤ **THE UBIQUITOUS** soybean finds its way into shredded breakfast cereal in

the formula on which W. P. Penty of Battle Creek, Mich., has obtained patent 2,421,216. The oil is first extracted, then the protein-rich residue, finely ground, is cooked and pressed into shreds along with ground grain. Patent rights are assigned to the Kellogg Company.

Industrial Alcohols

► BUTYL and isopropyl alcohols, useful in many industrial applications, are produced from a starch- or sugar-containing mash by fermentation with a special strain of the bacterial genus *Clostridium*, in a process on which patent 2,420,998 was issued to S. C. Beesch and D. A. Legg of Philadelphia, assignors to Publicker Industries, Inc.

For Fabric Printing

► AN EMULSION useful in printing fabrics is the subject of patent 2,421,000, granted to Edward Armatys of New York. Principal constituents are linseed oil, maleic anhydride and formaldehyde.

Safer Extinguisher Liquid

► SAFER FIRE-KILLING fluid for the "squirt-gun" type of extinguisher has been developed by David A. McLean of the Bell Telephone Laboratories

in New York. U. S. patent 2,421,035 has just been granted here on his invention.

Fire-smothering fluid generally used in this kind of extinguisher is carbon tetrachloride, familiar also as a household cleaning fluid. It is almost ideal for most types of fires, for it evaporates into a gas that displaces oxygen, without which fire cannot keep going.

However, when the fire takes place near metal, as in motor vehicle engine fires, an element of danger arises. On the hot metal surface, which apparently acts as a catalyst, part of the carbon tetrachloride combines with oxygen from the air, forming phosgene, which is one of the most poisonous of the military gases used in World War I. Fear of this danger prevents wider use of this otherwise excellent means of combating small fires, the inventor states.

Mr. McLean has found that phosgene formation can be suppressed by the addition of any of several substances to the carbon tetrachloride. Among these substances are the quinones, sulfur, maleic anhydride and the nitroaromatic compounds.

Whiskey Mere Distillery By-Product?

► WHISKEY may become a mere by-product of the distilleries.

If it does, it will be because the soluble wastes from making whiskey are worth more as feed for livestock and poultry than whiskey is as a drink. J. W. Spanyer, Jr., of the Brown-Forman Distillers Corp. believes that that time may come.

Solids from soluble waste, a liquid left at the bottom of the stills after the whiskey and "light grain" by-product have been removed, has produced startling results as a feed. The wastes are better feed than the original grain. Some experiments conducted by various universities have one distillery official to state that whiskey may eventually be the by-product.

Chemical Things To Do

Pictures by Flickering Light

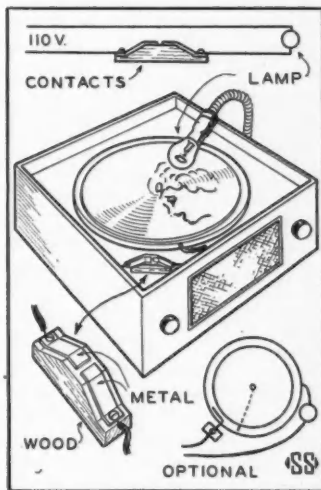
by JOSEPH H. KRAUS

► FLASHES OF LIGHT can be timed so accurately that they make the moving blades of a rotating electric fan appear to be motionless and a vibrating machine seem to stand still. A picture on a rotating disk can be seen clearly by means of stroboscopic illumination the name given to these flashes of light timed to flicker on at the right instant.

You can use any light bulb for a stroboscopic light. A neon mixed-gas glow lamp will give much better results, however, because the light comes up to its maximum brilliance instantly, and goes out again just as quickly. The filament of an ordinary electric light bulb takes appreciably longer to reach maximum intensity and there is a considerable lag before the hot filament is dark again.

To see a picture or design on a rotating phonograph, you will want to attach a simple switch beside the rotating disk. This will cause the light to flash on each time the turntable passes that particular point. Two types of switching arrangement can be used.

A simple circuit, called optional in the accompanying diagram, requires just a small block with a piece of bare copper wire attached to it. It is recommended for use on any spring-wound phonograph. It can also be used on electrically-driven turntables provided neither the motor nor the amplifier is grounded directly to one side of the source of power supply.



After attaching the copper wire to the block, bend it downward so that it just rests on the felt of your phonograph turntable. If your turntable has no felt, add a cardboard disk first. Now lay another piece of bare copper or brass wire on the turntable and twist it once around the center spindle. This wire should be just long enough to extend beyond the record and make contact with the wire attached to the block each time the turntable revolves.

Complete the Circuit

You can complete the circuit by grounding a copper lead to the motor. To do this, merely loosen one of the screws of your phonograph motor, or any other screw which fastens the

motor to the table, twist a bared end of insulated wire around the screw and tighten the screw again. Connect one side of a lamp socket to one lug of an attachment plug. Fasten a wire from the other lug of the plug to the bare copper contact on the wooden block. Run your grounded wire to the other side of the socket.

Screw a lamp into the socket and spin the turntable. You should get a flash at every revolution of the turntable. If you do not, your contact may not be working properly and need readjustment. Or your ground contact may be unsatisfactory, in which case you should attach the ground wire to some other screw reaching the motor.

A Safe Circuit

A circuit that is absolutely safe to use even on grounded devices is the dual contact illustrated at the center of the diagram. This consists of two metal strips cut from a tin can, attached to a small tapered block of wood. The strips are separated slightly.

A small bent piece of copper wire is pushed under the record so that it rests on the felt covering of the turntable. You may have to hold it there with a piece of tape.

The wire must not be grounded to

the turntable and should not touch any of its metal parts. If necessary, just bare the insulation from a small piece of insulated wire, push the insulated part under the record and let the bare portion extend beyond. Bend and adjust so that the bare strip of wire will just touch both metal plates. Now every time the turntable rotates, you will get a flash of light.

Either sketch a figure or paste a magazine cover to a phonograph record. Put out all the lights in the room. If the brush is properly adjusted, the intermittent flashes of light will permit you to see the picture in considerable detail.

The pictures on new phonograph records, popular of late, can also be seen while the turntable is rotating. Their clarity will depend upon the rapidity of the light flashes and the evenness of the rotating speed of your turntable.

If there is a slight "hunt" of the motor, the picture will be a little fuzzy. If the contact is dragged out too long, the picture will be blurred also, so make the contact as short as possible. Remember you need a quick flash of light to see the picture clearly. It is best to shield the light so you do not look directly at the bulb.

Colchicine Deforms Animals

► COLCHICINE, the drug that breeders have used to produce super-plants, is not so fortunate in its effects on animals. It has the same basic effect, of interfering with cell-division midway and producing abnormally large growth of some parts; but when injected into the bodies of young white rats before birth it produced mon-

strosities that could not live, Dr. John H. Van Dyke and Dr. M. G. Ritchey of the Washington University School of Medicine have reported.

Most of the deformities caused by the drug involved the forward parts of the embryos' bodies. However, one specimen did have a kinky tail. The tissues showed aberrant cell division.

New Metals Characterized By
A Green Line and a Blue One

Two Metals of Group III

Classics of Chemistry

Following the discovery of many rare earth metals came the appearance of scarcer but more orthodox metals which proved eventually to belong to Group III. Below are reprinted the original accounts of the discoveries of two of these. Each is characterized by a bright-colored line of its spectrum by which it was discovered and for which it was named. Thallium, which was not named until some time after the discovery described here, takes its name from the Greek word for a green twig. Indium was named for the indigo line of its spectrum.

Thallium

ON THE EXISTENCE OF A NEW ELEMENT, *probably of the Sulphur Group*, by William Crookes. *Chemical News*, Vol. 3, 1861.

➤ IN THE YEAR 1850 Professor Hofmann placed at my disposal upwards of ten pounds of the seleniferous deposit from the sulphuric acid manufactory at Tilkerode, in the Hartz Mountains, for the purpose of extracting from it the selenium, which was afterwards employed in an investigation upon the selenocyanides.¹ Some residues which were left in the purification of the crude selenium, and which, from their reactions, appeared to contain tellurium, were collected together and placed aside for examination at a more convenient opportunity. They remained unnoticed until the beginning of the present year, when, requiring some tellurium for experimental purposes, I attempted its extraction from these residues. Knowing that the spectra of the incandescent vapours of both selenium and tel-

lurium were free from any strongly-marked lines which might lead to the identification of either of these elements, it was not until I had in vain tried numerous chemical methods for isolating the tellurium which I supposed to be present, that the method of spectrum analysis was used.

A portion of the residue introduced into a gas-flame gave abundant evidence of selenium; but as the alternate light and dark bands due to this element became fainter, and I was expecting the appearance of the somewhat similar but closer bands of tellurium, suddenly a *bright-green line* flashed into view and quickly disappeared. An isolated green line in this portion of the spectrum was new to me. I had become intimately acquainted with the appearance of most of the artificial spectra during many years' investigation, and had never before met with a similar line to this; and as, from the chemical processes through which this residue had pass-

ed, the elements which could possibly be present were limited to a few, it became of interest to discover which of them occasioned this green line.

After numerous experiments, I have been led to the conclusion, that it is caused by the presence of a new element belonging to the sulphur group; but, unfortunately, the quantity of material upon which I have been able to experiment has been so small, that I hesitate to assert this very positively. I am, however, at work upon some of the seleniferous deposit itself, and hope shortly to be able to speak more confidently upon this point, as well as to give some account of its properties.

In the purest state that I have as yet succeeded in obtaining this substance, it communicates as definite a reaction to the flame as soda. The smallest trace introduced into the burner of the spectrum apparatus giving rise to a brilliant green line, perfectly sharp and well defined, upon a black ground, and almost rivalling the Na line in brilliancy. It is not, however, very lasting: owing to its volatility, which is almost as great as that of selenium, a portion introduced at once into a flame merely shows the line as a brilliant flash, remaining only a fraction of a second; but if it be introduced into the flame gradually, the line continues present for a much longer time.

The properties of the substance both in solution and in the dry state, as nearly as I can make out from the small quantity at my disposal, are the following:—

1. It is completely volatile below a red heat both in the elementary

state and in combination (except when united with a heavy fixed metal).

2. From its hydrochloric solution, it is readily precipitated by metallic zinc in the form of a heavy black powder, insoluble in the acid liquid.

3. Ammonia added very gradually until in slight excess to its acid solution gives no precipitate or colouration whatever, neither does the addition of carbonate or oxalate of ammonia to this alkaline solution.

4. Dry chlorine passed over it at a dull red heat unites with it, forming a readily volatile chloride soluble in water.

5. Sulphuretted hydrogen passed through its hydrochloric solution precipitates it incompletely, unless only a trace of free acid is present; but in an alkaline solution an immediate precipitation of a heavy black powder takes place.

6. Fused with nitre and carbonate of soda it becomes soluble in water, hydrochloric acid added in excess to this liquid producing a solution which answers to the above tests 2, 3, and 5.

An examination of these reactions shows that there are very few elements which could by the remotest possibility be mistaken for it.

The accompanying list includes every element, with the exception of the gases, bromine, iodine, and carbon. Opposite the name of each I have placed the number of the reaction which eliminates it from the list of possible substances, taking great care, in every case, to give the benefit of any doubt which might arise, on account of an imperfectly known or doubtful reaction, in favour of the opposite opinion which I desire to

prove, and in cases where several reactions would prove the same thing

only making use of the most trustworthy.

1, 5, Aluminum
Antimony
Arsenic
2, 3, 5, Barium
2, 3, 5, Beryllium
1, Bismuth
1, 2, 5, Boron
6, Cadmium
2, 5, Caesium
2, 3, 5, Calcium
1, 5, Cerium
1, Chromium
1, Cobalt
1, Copper
1, 5, Didymium
1, 5, Erbium
1, Gold
1, Ilmenium

1, Iridium
1, Iron
1, 5, Lanthanum
1, Lead
2, 5, Lithium
2, 5, Magnesium
1, Manganese
3, 6, Mercury
1, Molybdenum
1, Nickel
1, Niobium
5, Sulphur
1, Tantalum
Osmium
1, Palladium
5, Phosphorus
1, Platinum
2, 5, Potassium

1, Rhodium
1, Ruthenium
Selenium
1, 5, Silicium
1, Silver
2, 5, Sodium
2, 3, 5, Strontium
Tellurium
1, 5, Terbium
1, 5, Thorium
1, Tin
1, Titanium
1, Tungsten
1, Uranium
1, Vanadium
1, 5, Yttrium
2, Zinc
1, 5, Zirconium

There are, therefore, left the following, amongst which, if already known, it must occur:—Antimony, arsenic, osmium, selenium, and tellurium; and although, to my own mind, many of the reactions detailed above are sufficient proof that it cannot be one of the first three elements, yet I have thought it better to let them pass.

Each of the above five bodies, both in the elementary state and in combination, has been rigidly scrutinized, in the spectrum apparatus, by myself and many friends. Not a trace of such a line is shown by either of them in the green part of the spectrum. Antimony, arsenic, and osmium, in fact, giving continuous spectra, in which every colour is visible. The remaining elements, selenium and tellurium, might almost be dismissed unchallenged, inasmuch as I was first led to the examination by finding that it

was *not* either of these. Nevertheless, I have, as stated at the commencement of this paper, repeatedly examined their spectra, and find no trace of such a line, the alternate light and dark bands in the almost continuous spectra of selenium and tellurium forming, in fact, so strong a contrast to the single green ray of the new substance, that the latter may readily be detected in the presence of an enormous excess of either of the former.

In order to remove any remaining doubt which there might be as to the green line being due to any of the elements mentioned in the above list, I have moreover specially examined the spectra produced by each of these bodies in detail, either in their elementary state or in their most important compounds. Many of them give rise to spectra of great and characteristic beauty, but none give any-

thing like the green line, nor, in fact, is there any artificial spectrum except that of sodium which equals it in simplicity.

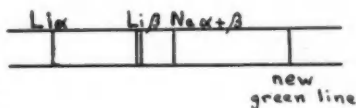
There still may be urged the possibility of its being a compound of two or more unknown elements, or an allotropic condition of one of them; a moment's thought will, however, show that neither of these hypotheses are tenable. They would in reality prove what they are raised to oppose, for nothing less could follow than a veritable transmutation of one body into another, and a consequent annihilation of all the groundwork upon which modern science is based.

If an element can be so changed as to have totally different chemical reactions, and to have the spectrum of its incandescent vapour (which is, *par excellence*, an elementary property) altered to an appearance totally unlike that given by its former self, it must have been changed into something which it originally was not.

The method of exhaustion, which I have adopted to prove the elementary character of the body which communicates this green line to the spectrum of the blue gas flame,² may seem unnecessary, as well as unchemical in the present state of the science. I was, however, obliged to rely upon what I may call circumstantial evidence of its not being a known element, owing to the very

small quantity of substance at my command—I believe I over-estimate the amount which I have as yet obtained at two grains—which preclude me from trying many reactions. The method of spectrum analysis, adopted to prove the same fact, although perfectly conclusive to my own mind, might not have been so to others, unsupported by chemical evidence.

The following diagram will serve to show the position in the spectrum which the new green line occupies with respect to the two lithium and the sodium lines:—



For confirmatory experiments on many of the observations mentioned in this paper I am indebted to my friend Mr. C. Greville Williams. The detailed examination of the various spectra are at present being jointly pursued by us, and will be published as soon as completed.

¹Quarterly Journal of the Chemical Society, iv. 12, and "Gmelin's Handbook" (Cavendish Society's translation), viii. 122.

²I need scarcely add that the line is quite distinct from either of the green or blue lines seen in a gas flame which is undergoing complete combustion. It is, moreover, far more brilliant than these.

Indium

PRELIMINARY NOTICE OF A NEW METAL, by F. Reich and Th. Richter. *Chemical News*, Vol. 7-8, 1863.

► THE AUTHORS have found a new metal in two Freiberg ores, which

were composed principally of arsenical pyrites, blende, and some lead-glance, together with silica, manganese, copper, and a small proportion of tin and cadmium. The ores were first

roasted to get rid of the greater part of the arsenic and sulphur, then mixed with hydrochloric acid, and distilled to dryness. The impure chloride of zinc obtained was examined with the spectroscope for thallium. No green line was seen, but the authors remarked an indigo-blue line, which was till then unknown.

The authors succeeded in isolating the conjectural substance, necessarily in very minute quantity, partly in the form of chloride, partly in the metallic state. On submitting these, moistened with hydrochloric acid, to the spectroscope, the blue line was seen so brilliant, sharp and persistent, that they did not hesitate to conclude that it belonged to a hitherto unrecognized metal, to which they accordingly gave the name *Indium*.

The line mentioned has a percepti-

bly greater refrangibility than the blue line of strontium, and there appears besides a much weaker line, of still greater refrangibility, which almost, but not quite, reaches the blue line of calcium.

The authors add that as far as they have examined the chemical properties of Indium they may safely assert that it is not precipitated from an acid solution of the chloride by sulphuretted hydrogen; that from the same solution it is precipitated by ammonia as a hydrated oxide; that the chloride is extremely deliquescent; and that the oxide heated on charcoal with soda gives lead-grey metallic beads, which are ductile and very soft; these heated again before the blowpipe give a yellowish slag, which, on further heating, takes no characteristic colour with cobalt solution.

Betatron Spots Flaws in Steel

► POWERFUL RADIATIONS from betatrons can be used for quick spotting of flaws in heavy steel, giving increased detail and greater speed than ordinary X-ray equipment. This promise of an important new tool for industry was emphasized as the new 20,000,000 electron volt betatron at the U. S. Army Arsenal, Picatinny, N. J., was demonstrated.

For industrial X-ray work, the betatron's radiations can penetrate 20 inches of steel in 20 minutes and detect flaws .002 inches wide and one thirty-second of an inch deep. By making enlargements on radiograph film directly, the machine speeds the time required for X-ray inspection.

One competent laboratory technician can operate the betatron, making it practical to X-ray with the betatron every piece of heavy equipment produced instead of the one out of 50 or 100 units as is now done, it was predicted.

Housed in a special X-ray laboratory, the new betatron is reported to be ready for use by medical and research groups seeking to perfect methods of applying betatron roentgen and electron radiations to clinical therapy.

The betatron combines a transformer winding and an X-ray tube in a porcelain "donut." The machine was built by Allis-Chalmers.

Mechanical Difficulties Have Delayed Use of Oldest Textile Fiber

Ramie the Versatile

by MARTHA G. MORROW

► RAMIE, probably the oldest plant fiber used by man, is one of the most promising of the "new" textile fibers. Perhaps used in wrapping the mummies of ancient Egypt, ramie is today an experimental fiber upon which millions of dollars and man-hours are being spent.

It is not growth of this stingless nettle that is holding back production, but lack of satisfactory mechanical methods for harvesting the plant, separating the fiber from the stems on a large scale and chemicals for cleaning them. Many of these difficulties have recently been ironed out, or show promise of being solved.

Ramie, the thin ring of fibers found just beneath the paper-thin bark of the plant, is one of the strongest of natural fibers. It is stronger than cotton, silk and even sturdy hemp.

Ramie absorbs water more readily than cotton. It can withstand torsion better than flax or hemp, but less well than cotton or silk. The fiber is about equal to cotton in elasticity.

When thoroughly cleaned of its natural gums and pectins, ramie's beautiful luster resembles that of silk. It takes dyes well and holds color better than most fabrics.

Banknote paper, typewriter ribbons, bandages, upholstery fabrics and carpet backing are a few of the uses visualized for hard-wearing, shrinkage-resistant ramie. Tire cord and yarn for insulating electrical cables present

challenging fields for future operation. Ramie is excellent for use in conveyor belts and industrial fabrics where wet strength is important. Sheets and pillowcases, toweling and draperies are also among the myriad purposes for which this fiber is suited.

Ramie can be spun, woven or knitted on standard textile machinery. It can be used alone or in combination with cotton, rayon or wool. In combination with rayon, for instance, ramie promises a material for shirts and summer dresses that will absorb perspiration easily and dry again quickly.

Unlike various other fabrics, particularly synthetics, ramie is much stronger wet than dry. Its tensile strength is sometimes as much as 60% to 90% higher when wet. The advantage of such a fiber for maritime use is apparent; it makes good cordage, fishing nets and sails.

Today ramie is grown commercially in China, Japan, Brazil and the Philippines. The crudely prepared raw fiber of China is known in international trade as "China grass." Adapted to a semi-tropical climate with an abundant rainfall on fertile soils, ramie is now being grown experimentally in the United States. About 3,000 acres of ramie are growing at present, but reports indicate more will be turned over to the plant this year. Ramie fiber is just beginning to appear on the market, the delay being partly due to delays in mill construction.



► **RAMIE FIBER** as it comes from the plant and after treatment and cutting to make it ready for spinning. The use of this beautiful textile fiber goes back to antiquity, but its commercial development has waited upon satisfactory means of mechanical handling. This photograph by Fremont Davis shows the samples contained in the Ramie Unit, *Things of Science*.

When mature, the plant is a straight stalk six to seven feet high, with few or no branches. From the upper quarter of the stalk grow large heart-shaped leaves. The stems are small, only one-half to three-quarters of an inch in diameter at the butt end. Scratch off the bark and there will be found a thin layer of individual fibers lying directly beneath. Within the ring of fibers is the natural woody

part of the stalk. After fraying a few of the fibers loose from one end of a dried stalk, a ribbon of fibers several feet long can be pulled from the stem.

When the green stems are allowed to mature, they usually turn brown and begin to seed at the top. If the stalk is allowed to continue to grow past its top fibrous stage, the fibers become coarse and brittle. Knowing when to harvest the stems is impor-

tant if the fiber is to be obtained at its best, with greatest length and maximum tensile strength.

Ramie is known botanically as *Boehmeria nivea*. It belongs to the nettle family, but does not have the stinging hairs common among nettles. The plant was introduced into the United States about 90 years ago.

Experimental plantings have grown best in the muck soils of the Florida Everglades and fertile alluvial stream beds along the Gulf of Mexico. Ramie has also produced well upon fertile, heavily-irrigated soils in the Southwest.

Although ramie can be grown from seed, it is usually propagated from pieces of root. Weeds must be controlled the first year, but after the second year the perennial usually becomes so well established that it crowds out other growths.

Ramie roots send up a new growth each spring. If the stems are cut during the growing season, which extends from April to November in Florida, a new crop immediately begins to grow and may attain a height of five to six feet in about 65 days. Under favorable conditions three or four crops may be obtained each season for ten years or longer.

To collect stems enough for immediate hand cleaning in primitive industries like those in China, ramie has traditionally been harvested by hand. In its natural growth, some of the plants mature before others, and even parts of the same outshoot of one cluster will be of different height and maturity.

Machine harvesting in some cases in the past may have resulted in in-

ferior, non-uniform fiber. More recently, however, careful cultivation and fertilization, use of superior ditching, draining and water control, and overall good management has produced a more even, steady growth of plants. This has made mechanical harvesting practical.

Experimental work has been undertaken by the U. S. Department of Agriculture in co-operation with state agricultural experiment stations to develop improved techniques.

A number of companies are interested in the cultivation of ramie and are actively trying to improve the plant and its preparation. These include the Newport Industries in co-operation with the U. S. Sugar Corporation, with the largest commercial output, and the Sea Island Mills, Inc. Others interested in Florida developments are Florida Ramie Products Corp., and Ramie Mills of Florida.

Ramie fiber may be separated from the rest of the stalk, a process known as decortication, either while the stems are still green or after they have dried out. In the Orient ramie fiber is scraped from the green stems by hand with crude implements, a workman separating only a few pounds of fiber each day. Need of an efficient mechanical cleaner, so that the American industry can compete with cheap Oriental labor, has been one of the important factors holding back greater production of ramie in this country.

Machines designed to mechanically scrape away the bark and woody core from the fiber are of two general types. Large, permanent decorticators separate the fiber from stems grown on thousands of near-by acres, the

stems being hauled some distance to the decorticator. But such installations require large financial investments. Transportation cost limits the area of usefulness although large output may offset haulage costs. Huge production machines also often injure the fiber badly.

Smaller, portable machines can be set up in the field where needed. This is an advantage, for not only need the stalks be carried but a short distance to the decorticator or the decorticator brought to the stems, but the green waste can easily be put back in the field, necessitating but slight chemical fertilization to support the next crop of heavy vegetable growth. Portable machines used heretofore, however, handled relatively few stems and called for many man-hours of work.

Since ramie was introduced to this country in 1855, a number of machines have been designed. Many are based on hemp and sisal machines with slight adjustments, others are developed specifically for ramie. Today many new types of decorticator are being designed and difficulties overcome.

Several firms are particularly interested in the end use of ramie, including Collins and Aikman; Sea Island Mills, Inc.; Johns-Manville and Silver Thread Co.

A large proportion of the ramie fiber is reduced to its ultimate cells, whereas flax, hemp and jute are rarely broken down so far. The ultimate cells of ramie are longer than those of any other plant-yielding fiber utilized in textiles or cordage. They average six to eight inches in length, and range from 0.002 to 0.003 inch in diameter.



➤ LENGTH OF FIBER characterizes the ramie plant. This photograph was taken in an experimental field of the U. S. Sugar Corporation.

The natural gums, waxes and pectins of the fiber are removed chemically. The ramie fiber coming from the decorticator is about one-fifth to one-third gum. The gum content of the fiber is next reduced to about four per cent so the fibers will be permanently separated from each other and in good condition for yarn spinning, or the fibers may be degummed at the spinning mill. Chemical processes for degumming ramie are as numerous and complex as the methods and machines for decortication.

The quantity of ramie obtained from an acre varies greatly in the United States. During a good season permitting four cuttings, 30 to 40 tons of green stems and tops have been

harvested. But fresh stems may yield only two to four per cent crude fiber, called ramie ribbons.

From 100 pounds of green stalks and leaves containing a high percentage of moisture, 52 pounds of stalks stripped of leaves may be salvaged. When air-dried, the stalks will weigh about 10.5 pounds. Only two to four pounds of decorticated fiber will be gotten from such a harvest, however,

resulting in but 1.2 to three pounds of degummed fiber as spun.

Many ramie specialists feel their work is still too much in the experimental stage and prices and competitive markets too unsettled to make definite predictions about the future of the fiber. But the number of acres planted in ramie is steadily increasing, indicating the faith of those working with this versatile fiber.

4,000-X Sweeter Than Sugar

➤ NEW SWEETNESS has come to a world troubled with a sugar shortage. It is a new compound 4,000 times as sweet as cane sugar.

By far the sweetest substance known to man, the sugar substitute was developed in the Netherlands during the war, Prof. Pieter Eduard Verkade of Delft Technical University has reported. The sweetening agent is now being manufactured in Europe, and an application for an American patent has been filed.

The new sweetening agent is derived from benzene and chemically is 1-n-propoxy-2-amino-4-nitrobenzene or n-propoxy for short. On your tongue, the tiniest pinch of the substance would still be tasted a half hour later.

Saccharin, the common sugar substitute derived from coal tar, is only 200 to 700 times as sweet as sugar, compared with the new compound's 4,000 times as sweet. Another substitute, dulcine, is 70 to 250 times as sweet. At your dinner table, the new benzene derivative could be diluted with lactose or milk sugar down to only 500 times the sweetness of cane sugar.

Easily obtained in the pure state, the new compound is in the form of orange crystals. The sweetener is only slightly soluble in water, but Prof. Verkade said its great sweetness made it satisfactory.

Ironically, the sweetest substance in the world known to chemists was developed during the war under the Nazi occupation of the Netherlands. Prof. Verkade disclosed that the Germans were interested in his work, but he was able to conceal his success from them.

The new substance is one of seven in the group chemists term the 1-alkoxy-2-amino-4-nitrobenzenes. Other members of this group range from 120 to 2,000 times as sweet as ordinary sugar. All compounds in this group have a purely sweet taste with no secondary or after-taste as some sugar substitutes have. Saccharin is a similar type of compound but has a sulfur atom in the molecule.

The n-propoxy compound is stable in boiling water and in not very strong acid solutions in contrast to saccharin. In some cases this instability has limited the use of saccharin.

A Museum in a Blue Box

Ramie

Turn to page 45
and read about:

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